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FIRE-TELEGRAPHY.

THE paper read last week at the Society of Telegraph-Engineers by Mr. Treuenfeld illustrates well the great progress made in fire-telegraphy during the last 20 years. Though a perusal of the mass of details in which the paper abounds might prove dry reading to those not directly interested in the subject, to those, on the other hand, whose time has been occupied in devising means for avoiding disastrous fires, the paper, from its statistical character, will be found of great value. It positively bristles with tables and data obtained in all cases, as Mr. Treuenfeld was careful to point out, from sources which must be considered the most reliable, namely, the official reports of the chiefs of the various fire brigades.

From the tables it appears that in London the number of fires occurring per annum has been nearly doubled in 20 years, but the serious fires are now only 7 per cent. of the total as against 25 per cent. in 1866. There must always be some difference of opinion regarding the exact amount of damage which must be done before a fire may be said to pass from the category of slight to that of serious fires; but, however this may be, it is most gratifying to find that the population has increased in a much greater ratio than the fires. In 1876 the population of London was 2,805,000 and the number of fires 1,632, whereas in 1886 the population was 4,149,000 and the fires 2,149, or for an increase amounting to nearly 50 per cent. in population we have an increase of slightly over 30 per cent. in the number of fires. The number of lives lost per 100 fires was rather higher in 1886 than in 1876, or 2·28 against 2·14. The lowest number during the last 10 years was 1·51 in 1878, the next to the lowest 1·76 in 1880, and the highest 2·28 in 1886. From this it appears that the means for the prevention of loss of life from fire have increased none too fast, and it is evident that the efficiency of the Fire Brigade must be based on the ratio of the number of fires to the number of lives lost as well as on the value of the property endangered to the value of the damage done. It appears that at the present time there is one alarm-point for every 6,880 inhabitants as against one for every 17,531 inhabitants in 1876. But for further statistical information we must refer our readers to the 15 tables the paper contains.

The value of the discussion which followed the reading of the paper was considerably enhanced by the remarks of a critic pre-eminently fitted to criticise, Capt. Shaw, the Chief of the Metropolitan Fire Brigade. Capt. Shaw spoke from the experience which he had obtained of the working of fire alarm telegraph systems, and did not hesitate to say that the Fire Brigade had received great benefit from them. The work of the brigade was much reduced, and the loss of property reduced in a greater ratio. But up to the present time there were grave objections attending their use, the chief of these arising from the very large percentage of false alarms sent through. One of the first things to be done was to protect the apparatus from interference, and Capt. Shaw suggested that the instrument should be constructed so that any person in giving an alarm to the station should at the same time make such a row that he would call the attention to himself of everyone within 100 yards of him. In the case of a false alarm identification of the culprit would then be easy, and punishment would follow if a satisfactory explanation were not forthcoming. The ringing of a bell to give the alarm is, said Capt. Shaw, most unsatisfactory. Telephones or speaking tubes would be much more satisfactory, as in many cases a few particulars which the ringing of a bell cannot give would enable the Brigade to do its work more efficiently.

We entirely agree with the opinion expressed by Capt. Shaw regarding automatic fire alarms. Generally speaking they cannot be relied on to act with certainty. We do not say that contact makers will not close the circuit when raised to a certain temperature, but unless they are fixed over the whole area of, say the warehouse which it is intended to protect, we cannot see how they are to be of much use. When a fire starts the heat generated is for some time confined to the locality of starting, and a fire may start anywhere in a warehouse. Unless there happens to be a contact maker, then, at every point or very near every point at which a fire can start, it follows that the alarm cannot be sounded in time to prevent a conflagration. Even when distributed all over the place the opening of a window or the shutting of a door, as Capt. Shaw said, disarranges the whole affair. Automatic alarms are certainly employed largely in America, but their sale is in the hands of insurance agents, and the statistics concerning their efficiency are not very reliable. Automatic sprinklers, on the other hand, seem to be growing in favour.

Mr. Bright who is well known in connection with fire telegraphy, remarked that insurance companies liked big fires because it brought a host of fresh insurers, while Mr. Hall, who spoke on behalf of the insurance companies modified this statement somewhat by declaring that they did not like them too big, but just big enough to stimulate the desire to insure. Altogether the paper and the discussion added considerably to our stock of information concerning fire-telegraphy.

IN his report to the Bradford Corporation, Dr. Hopkinson finally expresses the opinion that laying the cables in brick trenches would be the best. We have already urged that it is of vital importance that no mistake should arise with regard to such an important part of the plant as the main cables, and now the *Mechanical World* says, "We should have considered that the

opinions of those who have had practical experience of underground telegraphs ought to have been obtained, for the success of the undertaking will depend more upon the durability and reliability of the main connecting cable, than upon any other portion of the work. It is as yet an unsettled question as to the best system of underground connections, but we think this is probably due to the fact that those whose experience has been greatest in this direction have never been consulted. The failure of the underground main cables will do more to damage central station lighting than anything else, therefore no effort should be spared to make this portion of the work efficient, reliable and durable."

THE first of a short course of two lectures on "The Protection of Buildings from Lightning," was delivered by Prof. Oliver J. Lodge, F.R.S., on Saturday afternoon last. The lecturer began by giving a slight historical sketch of the subject, and called attention to the outstanding questions, difficulties, and points of controversy in connection with lightning conductors. He described the methods usually adopted, and showed that the reasons given for failure were often quite insufficient to account for it. An interesting experiment showed the effect of a minute quantity of electricity, and explained the reason of the large size of the rain-drops in thunder showers. As soon as a stick of sealing-wax rubbed on the coat sleeve, was presented in the neighbourhood of the jet of a tiny fountain, the drops previously falling in spray were collected, and fell as an almost continuous stream. In conclusion, the lecturer referred to the futility of ordinary galvanometer tests for lightning rods, and argued that the behaviour of a feeble battery current afforded no analogy whatever, by which to estimate the effect of the explosive and shattering lightning discharge. At the second lecture on Saturday next, experimental answers will be given to some of the questions raised, and an endeavour will be made to supply a more complete account of the liability of conductors to side flash than has yet been attempted.

THE prospectus of the Water Primary Battery Company (private and confidential) is worth perusing. The capital is fixed at £600,000 ! ! ! in shares of £1 each, and the first issue is to consist of 300,000 shares. The directors named are Col. G. B. Malleson, C.S.I., the Hon. Arthur Cadogan, and Basil Slade, Esq., with power to add to the number. We wonder if these gentlemen have assured themselves of the stability of the undertaking in which they have become interested. We read that the company was formed to purchase and work the *valuable* (the italics are ours) patents of Mons. D'Humy; that the battery has been successfully at work for eight or nine months, and that the applications for the battery have been so numerous as to necessitate large additional capital. M. D'Humy shows his confidence in his invention (surely this is not the old confidence trick in another guise!) by taking shares and debentures instead of money, which probably enough he could not get, and we are gravely assured that the success of the invention and of the company has been established. When and where? It is said that a contract has been signed with a French syndicate for the sale of the French patent for £100,000. This probably means that the option of purchase has been given. Further, that the Spanish contract for the execution of the work, in connection, we suppose, with the lighting of Madrid, will amount to about £200,000, leaving a profit of 30 to 40 per cent., and that it is satisfactory for the inventor and manager of this company to state that without making any calls upon the shareholders, or on the public, about 100 per cent. will be secured and paid to the original shareholders on the amount of their shares, and the repayment of £20,000 debentures secured. This puts the operations of the famous "Father Brush" in the shade. Intending investors are also assured that a specimen of a central station for electric lighting with the water primary battery has been continuously worked night and day without stopping, and that it has given satisfaction, as is proved by the scientific reports and opinions of the press. Of course this latter term applies with special force to the REVIEW. The rest of the prospectus is made up of the gibberish upon which we have previously commented, such as the extra steadiness of the light, the perfect economy, the sanitary advantages, the ability of the battery to assist accumulators in the execution of their duty, the pretty idea that children may play with it, which will doubtless touch the tender susceptibilities of fond parents, and twaddle of this kind *ad nauseam*. The estimated profit for the year 1888 appears to be based upon the *right* to manufacture batteries for France, the *right* to establish central stations on certain properties, and *negotiations* for lighting several theatres. The prospectus concludes with a sentence which should carry its own condemnation :—"By these contracts and negotiations with contractors and parties from various parts of the world for supplying the electric light, this company is now a *bona fide* going concern, and in a position to pay good dividends to the shareholders for many years to come." What Arcadian shareholders these to be contented to await the development of such visionary methods of turning an honest penny! Seriously speaking, is it not time that some steps were taken to form an Electrical Trades' Protection Society, or an Association for the Abolition of Primary Batteries?

THE reference to a new set of fire insurance rules from a correspondent induces us to ask a question. Is it really a fact that electrical contractors are quite contented with the "Phœnix" rules and wish for nothing better, and are other Insurance Companies altogether inclined to acknowledge these rules as thoroughly representative of their policy? Now that the blow has fallen, as our friend puts it, perhaps we may get a general opinion upon this vexed question.

THE notification from the Trades Union to Messrs. Crompton & Co., brief particulars of which can be seen in our "Notes," is very suggestive. The time may come, soon it is to be hoped, when the British Workman will seriously consider whether trades unionism, instead of being beneficial, is not actually detrimental to his prospects in life. We believe that the pet theory of this band of brotherhood is that there is only a certain amount of work to be done in the world, and that if this is done quickly there will be nothing more to go on with. What skilled workman would not rather labour on the piece work system, than for a stated weekly wage? A trades unionist without technical skill, energy, or love for his work, may be contented to retain his membership, but the prohibitions on the skilled workman who is willing to give his hard labour for a corresponding amount of hard cash must be terribly galling. It is easy to understand that in purely mechanical operations employers would not think of giving out piece work, but in operations where

great artistic taste or technical knowledge finds scope, it is hard for a man to be bound down to day work. There is much to be said on either side: time work plays into the hands of the lazy and incompetent, and piece work may become the means of scamping one's duties for the sake of the extra earnings; but trades unionism cannot adjust the balance. What say our readers?

THE Swiss Telephone Administration calls attention to the fact that the Bâle-Zurich trunk line is an experiment, whose object was to test on a long Swiss line the well known Van Rysselberghe system (telephoning on telegraph lines). This experiment was of very great importance for telephony, and to make it was therefore the duty of the Administration. If it had succeeded the difficulties and expense of long-distance connections would have been greatly reduced, and the development of telephony materially advanced. Unfortunately the desired results have not been attained, and the Administration is therefore compelled to make the connections by means of special and entirely independent lines, which in Switzerland is unusually difficult, because the country is already very full of telegraph and telephone lines, crossing each other in every direction, particularly in the neighbourhood of the large towns. The advisability and the cost of such a special line between Bâle and Zurich are now under examination, and if the question be decided favourably, the Administration will proceed to carry it out under the usual conditions, in spite of the considerable expense already fruitlessly incurred. Our information is derived from a Berne paper, and the abandonment of the much-lauded Van Rysselberghe system seems to point to its eventual condemnation.

LIEUT.-COL. BUCKNILL, in his papers on "Submarine Mining," now appearing in *Engineering*, speaks of an easily made high-resistance, with which he credits Mr. Johnson, of the well-known firm of Johnson and Phillips. It is formed by marking a pencil line on a block of vulcanite or glass, and then protecting it with varnish, the point of a sharp knife being used to scrape away the plumbago so as to reduce the width of the line until the desired resistance is obtained. Lieut.-Col. Bucknill quotes copiously from a letter which Mr. Johnson penned to him on September 2nd, 1879, giving details of the method: but the same thing in every particular was employed years previous to this date by the late Robert Sabine, for use when testing the West India and Panama cables, the writer of this note having partially constructed and tested the apparatus for him. They were made on slabs of both vulcanite and glass, and the same want of reliability, or, rather, constancy of resistance, which Mr. Johnson mentions, when on the first mentioned material, was observed. We fancy that the idea originated with Mr. Phillips, long before he had become associated with his present partner, and that Mr. Sabine was indebted to him for the suggestion.

MR. CROMPTON was perfectly correct in crediting Mr. Westinghouse with the remarkable spread of transformer systems. That gentleman's business faculties and powers of organisation enable him to surmount difficulties which most men would look at askance. But it must not be forgotten that enterprising natures like his are encouraged across the water to a much greater extent than in this country. Success in America, however, does not by any means guarantee a favourable reception here, except under very special circumstances, the conditions existing in the two countries being so dissimilar.

IT has been urged, in our own journal amongst others, that continuous current transformers of the Paris-Scott type should be tried upon a more extensive scale. We are not sure, however, whether any attention has been given to the fact that a large number of these machines in operation would probably increase the risks of a breakdown. By this we mean that it is generally moving machinery which fails in electric lighting installations. Whether we use alternating or continuous currents the transformer is a necessity for converting high tension currents into low, but in the former case this part of the plant has no moving parts. The prototype of the alternating current transformer is therefore the secondary battery. It must not be forgotten, however, that continuous current transformers can be employed in connection with accumulators.

A CORRESPONDENT was listening at his telephone, which connects a City office with Charlton, at 3.15 p.m. on February 27th. Morse signals in a peculiarly musical tone presently made themselves heard. Our correspondent patiently set himself to resolve these signals into language, and this was the result he achieved:—"Of course there is no induction on your side!" The telephone circuit is metallic, and almost entirely under ground.

Industries is of opinion that although there appears to be no reason why electric lighting companies should not enjoy a monopoly for the supply of the lighting, yet a clause should be added to Lord Thurlow's Bill prohibiting the use of overhead wires. With the result of American experience still fresh in one's mind, we think that but few will be inclined to disagree with our contemporary, especially so far as high tension systems are concerned: but we do not really see why there should be any cause for accident here if only proper precautions are observed. *Industries* hopes that before the Bill becomes law a clause will be inserted under which no electric light wire of any description will be allowed to hang overhead. This we take it is going a trifle too far, and would be more apt to stifle the new industry to a certain extent than to extend its scope. Naturally we do not support the promiscuous and happy-go-lucky style of stretching wires over house-tops in the glorious confusion in which they now exist, but we imagine it would not be a difficult matter to work out a thoroughly systematic and practical method of erecting them, and for crossing streets, which would exempt us from danger.

"UNTIL its mysteries are solved, only fools and idiots should talk about improving what they do not understand." Such is the *dictum* of *Money*: the subject, the talk there has been about improving the electric light. How can you improve that with the constituents of which you are unacquainted? says in effect our reproving contemporary. Now, there's gas; you know what that is—carbon and hydrogen. Therefore it is easy enough to improve it. But electricity—what is it? Nobody knows; therefore nobody can improve it. Oh, *Money*, *Money!* Read the wise remark with which you closed your paragraph, and which opens ours!

MAGNETIC "RESISTANCE."

By J. SWINBURNE.

BEFORE discussing the advisability of introducing such a term we must settle what we mean by it. In the electro-magnetic system we have resistance and specific resistance. Allowing for the present the analogy between induction and current density we want magnetic resistance of a circuit, and specific magnetic resistance of a substance. The specific magnetic resistance will then be $1/\mu$, the reciprocal of the permeability. The magnetic resistance of a circuit will vary inversely as μ and as the cross section, and directly as the length, so that in, for example, a closed iron ring wound with copper wire, the magnetic resistance would be

$$\frac{\text{length of magnetic circuit}}{\mu \times \text{cross section of iron}}$$

the iron circuit being alone considered. The total induction is then 4π times the current turns divided by the length of the circuit and multiplied by the area, centimetres being used. This total induction is the total number of lines of induction in C.G.S. units.

The advantages of the adoption of such a term as "magnetic resistance" may be discussed first. The introduction of the idea of "magnetic resistance" into dynamo construction is about ten years old, but has only come much to the front lately. In practical work it may often be convenient to talk of the magnetic resistance of the iron of, say, a dynamo, as it appeals to anyone whose ideas on the subject are not very clear. Similarly the idea of the specific magnetic resistance of a field magnet core rising when it gets saturated may be to some extent useful in explaining things.

The drawbacks seem to be very great. Beginning with the purely practical. The resistance of a copper wire is a definite quantity and so is the resistance of a circuit containing a cell, the whole being insulated, but the magnetic resistance of the iron circuit of a dynamo is not definite. For the sake of analogy imagine a ring of bare copper wire with a gap in it so as to be like the letter C. Let this be placed in a bath of mercury. Suppose now that the end of a magnet is pushed through. A current is induced in the copper and in the mercury. Suppose the magnet to be flexible and to wind itself round the wire: while it is doing so a current will be induced in the copper and in the mercury. To talk of the electrical resistance of this circuit would be meaningless, because the current has not the same value across different sections of the wire. It is greatest just where the magnet is winding itself on, and the leakage through the mercury lessens it elsewhere. If the coiling magnet does not embrace the wire closely there are also currents induced which flow entirely in the mercury and never enter the copper wire. In such a case Ohm's law would be of little use. E would be determinate, but C would not have any definite meaning. It could not denote the current in the copper wire because that has different values in different parts, and it could not denote the whole current in the copper and mercury because that is indeterminate. There are currents induced even in the magnet itself. R is thus also indefinite.

Turning to the case of a dynamo, the magnetic potential, or, rather, the line integral of the magnetising force due to the magnetising coils, is definite. The total induction is indefinite, because the total induction n the iron core varies even in the parts over which the coils are wound. The ratio of the magnetic potential to the total induction in the iron is therefore indeterminate. The total induction, including that in the air, is also indefinite. Of course, the case of the dynamo is at the further disadvantage that the permeability of the iron is not constant. The term magnetic resistance is then from this point of view vague and indefinite, and should therefore be discarded.

Turning to specific magnetic resistance, we simply have $1/\mu$. People have got into the way of using the term resistance and avoiding the term conductivity; but they are gradually coming round to speak of the conductivities of circuits in parallel; and in any case the idea of a reciprocal is not very difficult to grasp. Ohm's law is just as useful when stated that the current is the product of the electromotive force and the conductivity. Similarly as μ is in universal use for permeability, it is not very difficult for people to use it instead of $1/\mu$. If they prefer the latter, why not call it the impermeability, and thus avoid the term resistance?

If people are bent on getting the idea of magnetic resistance into their heads, why not call μ the specific permeability and $1/\mu$ the specific impermeability? The vague magnetic resistance would then be the impermeability. Of course this would be equally vague.

It has been assumed that "magnetic resistance" is to be measured in C.G.S. units. Of course, it may be used in a conglomeration of inches, minutes, and volts. A mixed induction unit is very convenient; it is chosen so that if the area of the armature cross-section or of half the armature is taken in inches, and the speed in revolutions per minute, and the armature conductors in outside wires, the product reads the electromotive force. Of course, it must be divided by 10^6 or some multiple of 10 to bring it to a convenient figure, but as such calculations are always made on the slide rule, that is nothing. These mixed expressions have been condemned, and at the Telegraph Engineers we lately had the amusing spectacle of two sets of speakers who could not understand each others' units. Of course, this was due to want of clearness on their part, not to any faults in the systems.

Similarly in practice the writer thinks of magnetic potential in ampère turns and the resulting induction in inch units. But, though he has probably done as much calculation in practical dynamo design as any one, he has never made use of the idea of magnetic resistance, nor thought of such a quantity, except in giving rough and ready explanations.

Passing to the scientific side of the question, we can take the Physical Society discussion first. Mr. Bosanquet's argument is, judging from the report, that the word "resistance" should mean the ratio of the cause to the effect. This is simply enlarging the meaning enormously. Profs. Thompson, Ayrton and Foster seem, if we are not misjudging them from the meagre report accessible, agreed with him in the main. The drawback to such an extension of meaning is small in cases like heat, pressure, &c.; but in the case of electricity, it makes the term cover so much that it becomes useless. For instance, if "resistance" = cause effect, the ratio of charge to electric displacement, of electric potential to electrostatic induction, and so on, as much as you please, are all electric resistance. The term thus becomes meaningless.

Mr. Bosanquet, according to the report, goes on to say that in some cases "resistances at a point = $\frac{d.\text{cause}}{d.\text{effect}}$." This does not seem right, in fact its meaning is not at all clear. Mr. Bosanquet defines magnetic resistance as "magnetomotive force/magnetic induction. If magnetomotive force is the magnetising force, this would be what might be called the specific magnetic resistance; but the author does not define magnetomotive force. He seems to object to M. Hospitalier's magnetic resistance, but there seems no reason why if specific magnetic resistance is admitted, magnetic resistance should not be admitted also. M. Hospitalier's is certainly more natural, always admitting the use of the term "resistance." Mr. Bosanquet says that objections have been raised against "magnetic resistance," because it is not of the same dimensions as electrical resistance, and that it varies with different conditions. The last is hardly an objection, but the first is vital.

"Specific magnetic conductivity" is analogous to specific inductive capacity, not to electric conductivity, and has the same dimensions as the former in the electrostatic system.

M. Bosanquet goes on to say that the same objections hold as to magnetic potential and electrical poten-

tial and to magnetomotive force and electromotive force. The objections do not hold, however. Magnetic and electrostatic potential are analogous. Similarly magnetising force and electromotive force in the electrostatic system are strictly analogous. The analogy between magnetising force and electromotive force measured in volts is, of course, wrong.

We have been here assuming that "resistance" is introduced correctly by enlarging its meaning. That is not, however, why magnetic resistance was introduced. It was introduced because it was supposed to be analogous to electric resistance as the term is commonly used. And the object was to explain the dependence of the induction on the magnetising force in a way suitable to the alleged capacity of the practical man. The term can do no good here because the term electromotive force is used incorrectly nearly universally as synonymous with difference of potential, and so such an analogy, even if not false, would not give people a clear idea of the difference between magnetising force and magnetic potential. Obscurity on this point may be seen in the discussions on magnetic resistance. To talk of a dynamo giving an electromotive of 100 volts at its terminals is incorrect. The term electromotive force is in such general use in this sense that it would be useless to try to alter it, but the confusion will make it impossible to avoid confusion if "magnetic resistance" is introduced. If one insisted that in an electric light circuit the electromotive force is the rate of fall of potential and that a volt was not strictly the unit of electromotive force, he would be an unpractical purist; but the loose use of the term "electromotive force" will prevent clear ideas of magnetising force being gained by the proposed analogy.

Finally, the strong objection remains which the writer has often urged against empirical formulæ for such things as dynamos, or incandescent lamps, or the assumption that alternating currents are harmonic functions and transformers have coefficients of induction; namely, that it is wrong to make people learn things that they must unlearn afterwards, and that a man with a wrong idea is more ignorant than if he had none at all.

KIRCHOFF'S LAWS AND THEIR APPLICATION.

By E. C. RIMINGTON.

(*Continued from page* 255.)

Consider now the application of determinants to the solution of linear simultaneous equations.

Take the case of three linear equations with three unknowns. A linear equation with three unknowns will always be of the form :—

$$a\,x + b\,y + c\,z = p.$$

If any one of the unknowns does not occur in the equation, the value of its coefficient is zero. Thus, in the equation $3\,x - 2\,y = 6$,

$$a = 3,\ b = -2,\ c = 0, \text{ and } p = 6.$$

Let the three equations which are to be solved be :

$$a_1\,x + b_1\,y + c_1\,z = p_1 \qquad (1)$$

$$a_2\,x + b_2\,y + c_2\,z = p_2 \qquad (2)$$

$$a_3\,x + b_3\,y + c_3\,z = p_3 \qquad (3)$$

Multiplying (1) by b_2 and (2) by b_1, and subtracting we have :

$$x\,(a_1\,b_2 - a_2\,b_1) + z\,(b_2\,c_1 - b_1\,c_2) = p_1\,b_2 - p_2\,b_1 \qquad (4)$$

Similarly from (1) and (3)

$$x\,(a_1\,b_3 - a_3\,b_1) + z\,(b_3\,c_1 - b_1\,c_3) = p_1\,b_3 - p_3\,b_1 \qquad (5)$$

Multiply (4) by the coefficient of z in (5) and (5) by the coefficient of z in (4) and subtract. This gives

$$x\,\{(a_1\,b_2 - a_2\,b_1)\,(b_3\,c_1 - b_1\,c_3) - (a_1\,b_3 - a_3\,b_1)\,(b_2\,c_1 - b_1\,c_2)\}$$
$$= (p_1\,b_2 - p_2\,b_1)\,(b_3\,c_1 - b_1\,c_3) - (p_1\,b_3 - p_3\,b_1)\,(b_2\,c_1 - b_1\,c_2)$$
$$x\,(a_1\,b_2\,b_3\,c_1 - a_1\,b_1\,b_2\,c_3 - a_2\,b_1\,b_3\,c_1 + a_2\,b_1^2\,c_3 - a_1\,b_2\,b_3\,c_1$$
$$+ a_1\,b_1\,b_3\,c_2 + a_3\,b_1\,b_2\,c_1 - a_3\,b_1^2\,c_2)$$
$$= p_1\,b_2\,b_3\,c_1 - p_1\,b_1\,b_2\,c_3 - p_2\,b_1\,b_3\,c_1 + p_2\,b_1^2\,c_3 - p_1\,b_2\,b_3\,c_1$$
$$+ p_1\,b_1\,b_3\,c_2 + p_3\,b_1\,b_2\,c_1 - p_3\,b_1^2\,c_2$$

Cancelling and dividing each side by $-\,b_1$ we obtain

$$x\,(a_1\,b_2\,c_3 - a_1\,b_3\,c_2 + a_2\,b_3\,c_1 - a_2\,b_1\,c_3 + a_3\,b_1\,c_2 - a_3\,b_2\,c_1)$$
$$= p_1\,b_2\,c_3 - p_1\,b_3\,c_2 + p_2\,b_3\,c_1 - p_2\,b_1\,c_3 + p_3\,b_1\,c_2 - p_3\,b_2\,c_1$$

Now the coefficient of x is the value of the determinant

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix};$$

and the right-hand side of the equation the value of

$$\begin{vmatrix} p_1 & b_1 & c_1 \\ p_2 & b_2 & c_2 \\ p_3 & b_3 & c_3 \end{vmatrix}$$

Hence

$$x = \frac{\begin{vmatrix} p_1 & b_1 & c_1 \\ p_2 & b_2 & c_2 \\ p_3 & b_3 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}}$$

The value of

$$y = \frac{\begin{vmatrix} a_1 & p_1 & c_1 \\ a_2 & p_2 & c_2 \\ a_3 & p_3 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}}$$

This can be shown thus : write the equations

$$b_1\,y + a_1\,x + c_1\,z = p_1$$

$$b_2\,y + a_2\,x + c_2\,z = p_2$$

$$b_3\,y + a_3\,x + c_3\,z = p_3$$

Then, from the above :

$$y = \frac{\begin{vmatrix} p_1 & a_1 & c_1 \\ p_2 & a_2 & c_2 \\ p_3 & a_3 & c_3 \end{vmatrix}}{\begin{vmatrix} b_1 & a_1 & c_1 \\ b_2 & a_2 & c_2 \\ b_3 & a_3 & c_3 \end{vmatrix}} = \frac{\begin{vmatrix} a_1 & p_1 & c_1 \\ a_2 & p_2 & c_2 \\ a_3 & p_3 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}}$$

Similarly

$$z = \frac{\begin{vmatrix} a_1 & b_1 & p_1 \\ a_2 & b_2 & p_2 \\ a_3 & b_3 & p_3 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}}$$

In a similar manner it might be shown for more equations, but from the general theory of determinants it can be proved that if there are n linear equations of the forms :

$$a_1\,x + b_1\,y + \ \ldots\ + n_1\,v = p_1$$
$$a_2\,x + b_2\,y + \ \ldots\ + n_2\,v = p_2$$
$$\ldots \qquad \ldots \qquad \ldots$$
$$\ldots \qquad \ldots \qquad \ldots$$
$$a_n\,x + b_n\,y + \ \ldots\ + n_n\,v = p_n$$

$$x = \frac{\begin{vmatrix} p_1 & b_1 & \dots & n_1 \\ p_2 & b_2 & \dots & n_2 \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ p_n & b_n & \dots & n_n \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & \dots & n_1 \\ a_2 & b_2 & \dots & n_2 \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ a_n & b_n & \dots & n_n \end{vmatrix}} \quad y = \frac{\begin{vmatrix} a_1 & p_1 & \dots & n_1 \\ a_2 & p_2 & \dots & n_2 \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ a_n & p_n & \dots & n_n \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & \dots & n_1 \\ a_2 & b_2 & \dots & n_2 \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ a_n & b_n & \dots & n_n \end{vmatrix}}$$

and so on for the values of the other unknowns.

It will be noticed that in the values of all the unknowns the denominator is the same, and that the numerator is formed from the denominator by substituting the column formed from the right-hand sides of the equations for the column formed from the coefficients of the unknown, whose value is required; also the order of the determinants is equal to the number of unknowns. Thus the value of y in the case of three equations is a fraction in which the denominator is of the third order, and whose columns are the coefficients of x, y and z respectively, the rows being the coefficients of the first, second and third equations respectively; the numerator is formed by substituting the column $p_1\ p_2\ p_3$ for the column $b_1\ b_2\ b_3$, which is the column of the coefficients of y.

We have thus the following rule:

"When there are a number of linear equations containing several unknowns, there being as many independent equations as there are unknowns; the value of any one of the unknowns is a fraction, whose denominator is a determinant, the first column of which is formed of the coefficients of the first unknown, the second column being formed from the coefficients of the second unknown and so on, and whose first row is composed of the coefficients of the first equation, the second row being composed of those of the second equation and so on. The numerator is formed from the denominator by substituting a column formed of the quantities in the equations, which are not coefficients of any of the unknowns, for the column formed from the coefficients of the unknown, whose value is required."

As a numerical example of the above rule, suppose the value of x is required to be found from the following four equations:

$$\begin{aligned} 2x - 3y + z &= 2 \\ y + z + w &= 6 \\ 5x - 6z + w &= 0 \\ -x + 2y + 4w &= 5 \end{aligned}$$

These may be written

$$\begin{aligned} 2x - 3y + 1z + 0w &= 2 \\ 0x + 1y + 1z + 1w &= 6 \\ 5x + 0y - 6z + 1w &= 0 \\ -1x + 2y + 0z + 4w &= 5 \end{aligned}$$

$$x = \frac{\begin{vmatrix} 2 & -3 & 1 & 0 \\ 6 & 1 & 1 & 1 \\ 0 & 0 & -6 & 1 \\ 5 & 2 & 0 & 4 \end{vmatrix}}{\begin{vmatrix} 2 & -3 & 1 & 0 \\ 0 & 1 & 1 & 1 \\ 5 & 0 & -6 & 1 \\ -1 & 2 & 0 & 4 \end{vmatrix}} = \frac{\begin{vmatrix} 0 & -3 & 1 & 2 \\ 1 & 1 & 1 & 6 \\ 1 & 0 & -6 & 0 \\ 4 & 2 & 0 & 5 \end{vmatrix}}{\begin{vmatrix} 0 & -3 & 1 & 2 \\ 1 & 1 & 1 & 0 \\ 1 & 0 & -6 & 5 \\ 4 & 2 & 0 & -1 \end{vmatrix}}$$

$$= \frac{\begin{vmatrix} 0 & -3 & 1 & 2 \\ 1 & 1 & 1 & 6 \\ 0 & -1 & -7 & -6 \\ 0 & -2 & -4 & -19 \end{vmatrix}}{\begin{vmatrix} 0 & -3 & 1 & 2 \\ 1 & 1 & 1 & 0 \\ 0 & -1 & -7 & 5 \\ 0 & -2 & -4 & -1 \end{vmatrix}} = \frac{\begin{vmatrix} -1 & -7 & -6 \\ -2 & -4 & -19 \\ -3 & 1 & 2 \end{vmatrix}}{\begin{vmatrix} -1 & -7 & 5 \\ -2 & -4 & -1 \\ -3 & 1 & 2 \end{vmatrix}}$$

$$= \frac{\begin{vmatrix} -1 & -7 & -6 \\ 0 & 10 & -7 \\ 0 & 22 & 20 \end{vmatrix}}{\begin{vmatrix} -1 & -7 & 5 \\ 0 & 10 & -11 \\ 0 & 22 & -13 \end{vmatrix}} = \frac{\begin{vmatrix} 10 & -7 \\ 22 & 20 \end{vmatrix}}{\begin{vmatrix} 10 & -11 \\ 22 & -13 \end{vmatrix}} = \frac{200 + 154}{242 - 130} = 3{\cdot}16$$

Consider now the five equations given on page 226, viz.:

$$\begin{aligned} (r_1 + r_5 + r_6)x - r_6 y - r_5 z - 0w - 0v &= e_6 \\ -r_6 x + (r_2 + r_6 + r_7)y - 0z - r_7 w - 0v &= e_7 - e_6 \\ -r_5 x - 0y + (r_4 + r_5 + r_8)z - r_8 w - r_4 v &= -e_4 \\ -0x - r_7 y - r_8 z + (r_3 + r_7 + r_8)w - 0v &= e_3 - e_7 \\ -0x - 0y - r_4 z - r_3 w + (r_3 + r_4 + r_9)v &= e_4 - e_3 - e_9 \end{aligned}$$

$$x = \frac{\begin{vmatrix} e_6 & -r_6 & -r_5 & 0 & 0 \\ e_7 - e_6 & r_2 + r_6 + r_7 & 0 & -r_7 & 0 \\ -e_4 & 0 & r_4 + r_5 + r_8 & -r_8 & -r_4 \\ e_3 - e_7 & -r_7 & -r_8 & r_3 + r_7 + r_8 & 0 \\ e_4 - e_3 - e_9 & 0 & -r_4 & -r_3 & r_3 + r_4 + r_9 \end{vmatrix}}{\begin{vmatrix} r_1 + r_5 + r_6 & -r_6 & -r_5 & 0 & 0 \\ -r_6 & r_2 + r_6 + r_7 & 0 & -r_7 & 0 \\ -r_5 & 0 & r_4 + r_5 + r_8 & -r_8 & -r_4 \\ 0 & -r_7 & -r_8 & r_3 + r_7 + r_8 & 0 \\ 0 & 0 & -r_4 & -r_3 & r_3 + r_4 + r_9 \end{vmatrix}}$$

Similarly the value of y is found by substituting the column of E.M.Fs. for the second column of the denominator determinant instead of for the first. Suppose in the above that the resistances have all the value r_1, and the E.M.Fs. the value e.

Then

$$x = \frac{\begin{vmatrix} e & -r & -r & 0 & 0 \\ 0 & 3r & 0 & -r & 0 \\ -e & 0 & 3r & -r & -r \\ 0 & -r & -r & 3r & 0 \\ -e & 0 & -r & -r & 3r \end{vmatrix}}{\begin{vmatrix} 3r & -r & -r & 0 & 0 \\ -r & 3r & 0 & -r & 0 \\ -r & 0 & 3r & -r & -r \\ 0 & -r & -r & 3r & 0 \\ 0 & 0 & -r & -r & 3r \end{vmatrix}} = \frac{\begin{vmatrix} e & -r & -r & 0 & 0 \\ 0 & 3r & 0 & -r & 0 \\ 0 & -r & 2r & -r & -r \\ 0 & -r & -r & 3r & 0 \\ 0 & -r & -2r & -r & 3r \end{vmatrix}}{\begin{vmatrix} 0 & 8r & -r & -3r & 0 \\ -r & 3r & 0 & -r & 0 \\ 0 & -3r & 3r & 0 & -r \\ 0 & -r & -r & 3r & 0 \\ 0 & 0 & -r & -r & 3r \end{vmatrix}}$$

$$= \frac{e\,r^4 \begin{vmatrix} 3 & 0 & -1 & 0 \\ -1 & 2 & -1 & -1 \\ -1 & -1 & 3 & 0 \\ -1 & -2 & -1 & 3 \end{vmatrix}}{-r^5 \begin{vmatrix} -3 & 3 & 0 & -1 \\ -1 & -1 & 3 & 0 \\ 0 & -1 & -1 & 3 \\ 8 & -1 & -3 & 0 \end{vmatrix}} = \frac{-e \begin{vmatrix} -1 & -4 & 2 \\ 0 & 8 & -1 \\ 3 & -4 & -2 \end{vmatrix}}{-(-1)r \begin{vmatrix} -1 & -1 & 3 \\ -9 & 21 & 0 \\ 6 & -9 & -1 \end{vmatrix}}$$

$$= \frac{+e \begin{vmatrix} 8 & -1 \\ -16 & 4 \end{vmatrix}}{-r \begin{vmatrix} 30 & -27 \\ -15 & 17 \end{vmatrix}} = \frac{e\,(32 - 16)}{-r\,(510 - 405)} = -\frac{16\,e}{105\,r}$$

If $e = 1$ volt and $r = 1$ ohm, $x = -{\cdot}15238$ ampère: that is to say, the actual current in the branch (1) of the figure, page 226, is ·15238 ampère and flows in a counter-clockwise direction through the branch.

In the same manner the other cyclic symbols, y, z, w and v, may be found; and, when they are determined, the value of the actual current in every branch is known, as was before pointed out.

(To be continued.)

THE COUPLING OF ALTERNATING CURRENT DYNAMOS IN PARALLEL CIRCUIT.

By Dr. G. STERN, Engineer, of Ganz & Co., Budapest.

THE theoretical aspect of alternate current dynamos working in parallel has been treated by Jno. Hopkinson, D.Sc. (lecture at the Institution of Civil Engineers, session 1882–83). He then proved that alternate current dynamos coupled in series tend to annul their current, and their phases of E.M.F. come finally to be diametrically opposed. This is not the case with alternate current dynamos coupled in parallel; but, on the contrary, if the dynamos are not prevented by mechanical coupling, the currents add themselves. This equalising of the phases takes place usually so suddenly that the mechanical means of driving the dynamos may suffer, and the lamps or motors on the circuit are subjected to severe alterations of pressure.

If two dynamos with nearly the same number of alternations be run independently of one another, their phases at certain intervals will be like as two musical notes of approximately the same number of vibrations produce undulatory variations of loudness. The beforementioned evil effects can be avoided if the dynamos are coupled up at an instant when their phases agree. In order to recognise this instant of agreement there are simple means.

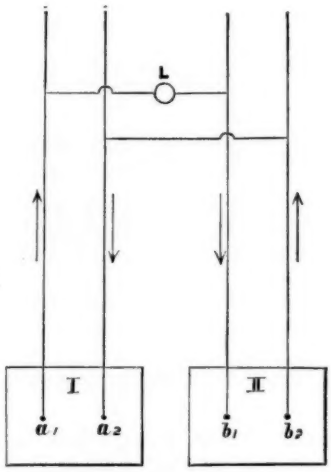


FIG. 1.

The terminals of two alternate current dynamos being connected by a comparatively high resistance, current will flow through these connections in the direction of the resultant E.M.F. of both dynamos; for example, the terminals, a_1, being connected to b_1, and a_2 to b_2 (figs. 1 and 2), the lamp, L, being between a_1 and b_1, arrows indicating the direction of current, in fig. 1 the dynamos are acting through the connections as if in series, the pressure across the lamp being double that of one machine, but on account of the variability of the difference of phase, which is already determined by the minimum difference of the number of revolutions, the just described coincidence will take place only at certain intervals, and at some other times the current will be directed as in fig. 2. In this case, given equal mean pressures at the terminals of both dynamos, there will be no current in the connections. It follows from what has just been said that the pressure over the lamp, L, varies at certain intervals from zero to double the pressure of one machine.

The parallel coupling of the dynamos with equal phase will be possible when the pressure in the connections is a maximum, if a_1 and b_2 be connected to one end of the main leads and a_2 and b_1 to the other; with no pressure in the connections, the coupling up will be possible when a_1 and b_1 are connected to one and a_2 and b_2 to the other end of the main leads.

Led by these observations, the electricians of Messrs. Ganz & Co., Budapest, devised some years since the arrangements described hereafter, and which are still in constant use.

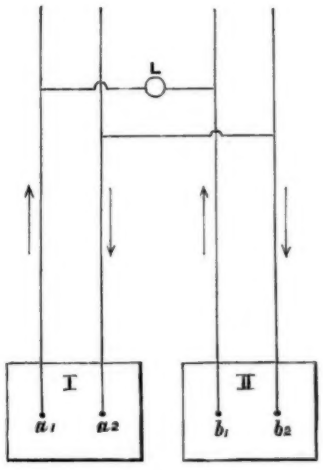


FIG. 2.

Two terminals of the dynamos—say, a_2 and b_2—are connected together (see fig. 2); between the other two terminals, a_1 and b_1, is placed the apparatus for showing the pressure, which may be an incandescent lamp of suitable resistance. The dynamos being run, the lamp will alternately give light and no light. Supposing that dynamo No. 1 is already sending its current into the main leads at a time when the lamp gives no light, the terminal b_1 of dynamo No. 2 is connected with the terminal a_1 of dynamo No. 1, and the operation of switching into circuit is complete.

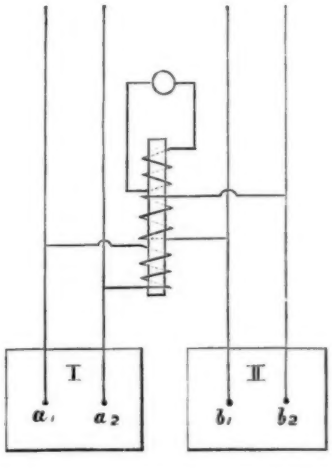


FIG. 3.

The time when the lamp gives its strongest light can also be utilised, with the difference that a_1 and b_2 be connected to the same main lead, and a_2 and b_1 to the other. Care, however, must be taken with this arrangement that, at the instant of coupling, the connecting lead from a_2 to b_2 be broken (that is, if this lead does not possess a high resistance, as the connecting lead a_1 b_1), otherwise it forms a short circuit.

With high tension currents, as used in the Zipernowsky-Deri-Blathy system, a small transformer is placed where the lamp, L, is shown in the foregoing

figures ; this transformer has, in its secondary circuit, a lamp or other pressure-indicating instrument. If the lamp used for this purpose require the same E.M.F. as the others on the main circuit, the ratio of the transformer must be double that of the other transformers in circuit.

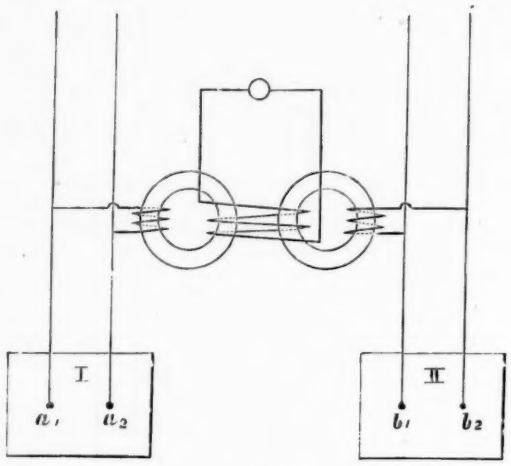


FIG. 4.

A somewhat different arrangement is shown in fig. 3. Here it is not the case that a current produced by the difference of phase of two alternating currents in a lead connecting both is measured, but advantage is taken of the effect produced by two alternating currents of different phase on a third conductor, which is at the same part subject to the induction of both. An alternating current transformer has three coils, two of which are connected in parallel to the leads from the dynamos, as shown ; the other, the secondary, supplies the lamp or other measuring instrument. It will then happen that at different times the core will be magnetised, and at other times the currents will be opposed in phase, producing no magnetic effect in the core ; as the lamp is in the secondary circuit, it will be affected. The proper time to set in circuit the spare dynamo may thus be chosen, taking account of the directions of the currents, as was before done.

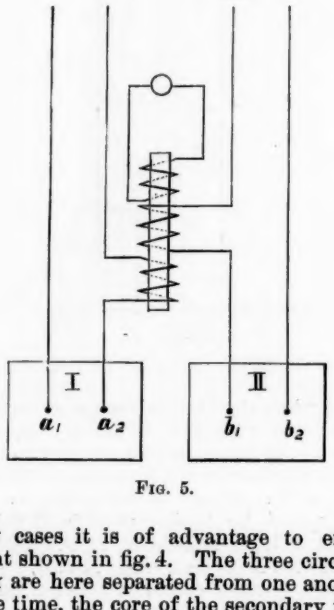


FIG. 5.

In many cases it is of advantage to employ the arrangement shown in fig. 4. The three circuits in the transformer are here separated from one another ; but, at the same time, the core of the secondary is common to both of the primary cores.

By the methods shown in figs. 3 and 4, besides the coincidence of phase of both dynamos, it can also be determined from the behaviour of the indicating apparatus, when the E.M.Fs. of both machines are equal. In figs. 5 and 6, where the currents from the dynamos are used in series to the indicator-transformer instead of parallel connection, as in figs. 3 and 4, the change of light in the lamp will only show the relative E.M.Fs. of the dynamos ; this, however, is of no practical importance.

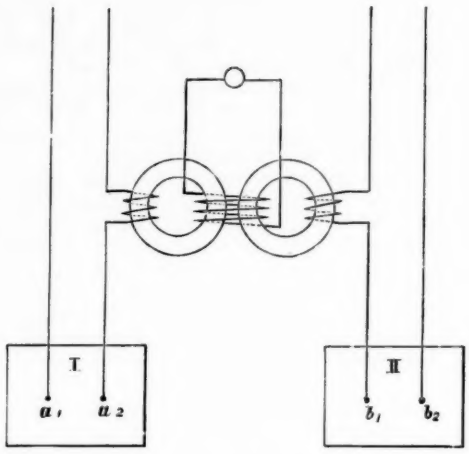


FIG. 6.

The lamp is in many cases to be employed with advantage in connection with other kinds of indicating apparatus, such as electric bells, galvanometers, or the like.

Instead of setting a fresh dynamo in circuit by means of a hand switch, an automatic switch in connection with the indicator has been used ; but this is only an unnecessary complication, as for such an important operation the presence of a careful attendant is always absolutely necessary.

LEAMINGTON ELECTRIC LIGHT INSTALLATION.

THE news lately received from Leamington is not very reassuring to those who would desire to see even a moderate amount of success attend the electric lighting of that town.

At the recent meeting of the *patres conscripti*, when the question of certain payments was mooted, the general disgust at the inefficiency of the system was evidenced by a proposal to give immediate notice to terminate the contract ; more generous counsels prevailed, however, and the electric lighting company was granted a brief respite.

During the discussion it transpired that out of the six dynamos employed five had been rendered useless through short circuiting, a heavy loss to the contracting company being entailed. We defer any comments on this extraordinary series of misfortunes until we can, as we hope shortly to be in a position to, lay before our readers more complete details.

Truly the townspeople of Leamington are deserving of sympathy. After submitting to the inevitable inconvenience of having their streets opened out for the placing of the conduits, they have had to bear with a resurrectionary operation in quest of a presumed fault in the mains, a labour which, according to report, has hitherto proved in vain. Then having cut off a portion of their gas illumination, depending on the electric light, the latter failed them. A really amusing incident in connection with this matter was that, during

their deliberations, the "City Fathers" had an actual experience of the unreliable character of their new light, and, as we have previously notified, they found themselves in a similar position to that once credited to Moses.

We do not intend discussing the question whether the conditions requisite for good street illumination are better fulfilled by gas or by the electric light, but it is beyond dispute a matter to be very much regretted that such an unfortunate *contretemps* in town electric lighting should have occurred, as it can but strengthen the arguments of those who support gas lighting. The consequences, easily foretold in this particular instance, must be, unless some well accredited firm steps forward and offers to carry out the electric lighting of the town at its own risk, and subject to stringent restrictions and severe penalties, that the town authorities, upon the termination of the present contract, will assuredly return to the use of gas, and with not altogether unreasonable grounds for trusting to a less brilliant, but more reliable illuminant. This indeed would be an event greatly to be deplored, for notwithstanding the success obtained with the electric light in other quarters and under different conditions, much discredit to this method of lighting must inevitably result. Let us hope that the contracting company may speedily find means to remedy those defects, which are not only prejudicial to its own interests, but affect all concerned in the extension of electric lighting.

We extract the following notices of the failure of the electric light at Leamington from a local journal :—

"On Tuesday night [last week] the General Purposes Committee had a long interview with Mr. Chamberlain respecting the unsatisfactory character of the electric light in the public streets. Considerable dissatisfaction was expressed, but Mr. Chamberlain pleaded that the company were working under difficulties, and were doing their best to overcome the obstacles to the success of the light."

"At the meeting of the Town Council on Monday [this presumably took place on Monday last] Mr. Councillor Orton will move: 'That unless the Electric Lighting Company have completed their experiment, and the electric light is in perfect working order to the satisfaction of this Council by March 31st next, this Council do then take steps to have a portion of the lamps on the Parade lighted with gas, to prevent the possibility of its being left in darkness.'"

TELEGRAPHIC COMMUNICATION WITH LIGHTHOUSES.

At the Plymouth Chamber of Commerce, on Thursday week, an important discussion took place regarding the above subject. A report was presented by Mr. Bayly, who said that it required few words to convince such an assembly as that, that Great Britain was far behind other countries in the matter of telegraphic communication with lighthouses and along the coast. The only question was as to who should pay the cost. He considered that the loss of ships and lives constituted a national disaster, and on that ground the Post Office might well be called upon to provide the communication which was so much needed, although it might not always be a directly remunerative undertaking. In the cases of the *Schiller*, which was lost off Scilly, and the *Soudan*, which was wrecked off Plymouth, much life and property would in all probability have been saved if there had been telegraphic communication between lighthouses and the shore. Mr. Collier hoped that the Plymouth Chamber would stick to their point until they could bring it to a successful issue, for it was a question which peculiarly affected Plymouth, where they knew so much about shipping and the state of the coast. Trinity House objected to lighthouses being converted into signal stations, but he contended that the establishment of the proposed telegraphic communication would have no such effect, because the wires would only be used under circumstances of great importance. Communication along the coast by means of the coastguard had also become an urgent necessity, and Lord Morley could do nothing more valuable either to them or to the State than to bring the question before the House of Lords. Lord Morley commented on the enormous importance of the subject, both in relation to the saving of life and to national defence, which would be vastly improved by an efficient system of telegraphic communication along the coast. He had not studied the question sufficiently to be acquainted with all its bearings, but without pledging himself to any particular line of action he should be pleased to further in any way he possibly could the admirable object which the Chamber had in view. It was agreed to present a memorial to the executive of the Associated Chambers, who, if they approve it, will present it to the Government. This document draws the attention of the Government to the great necessity that exists for placing lighthouses, lightships, coastguard, and lifeboat stations into telegraphic communication with the telegraph system of the country. It is not asked that this communication should be made in every case where the cost and difficulties may be exceptionally heavy, but that in the first instance at least all the salient points of the coasts where wrecks have occurred should be dealt with in the manner suggested. Attention is called to the utter absence of any means at the present time by which the Admiralty authorities could cause the movements of the ships of H.M. Navy or of those of a foreign Power to be signalled off the British coast. The proposed telegraphic communication would be of the greatest possible value in case of war. With reference to lighthouses and lightships, although not under the direct control of the Government, they are national property, and if provided with electrical communication would be of immense benefit for the purposes of Imperial defence. With regard to the safety of life, the memorial cites the evidence given before the committee appointed by the Board of Trade to inquire into the matter, when one of the principal witnesses said that disastrous wrecks had occurred in the vicinity of lightships and lighthouses, where the crews had perished in consequence of the inability of the lightship or lighthouse keepers to communicate the intelligence to those ashore.

A NEW PATTERN OF REFLECTING GALVANOMETER WITH LAMP AND SCALE.*

By G. L. ADDENBROOKE.

The instruments which I am about to describe are the outcome of improvements and modifications which have suggested themselves from time to time as the result of a good deal of experience in electrical testing for telephonic, electric lighting and general experimental purposes. As usually constructed the reflecting galvanometer is essentially a laboratory instrument, demanding care and skill for its management, besides being costly. Perhaps the greatest objections to it are, however, the difficulty of moving it and setting it up, and the time usually taken to put it right when it gets out of order.

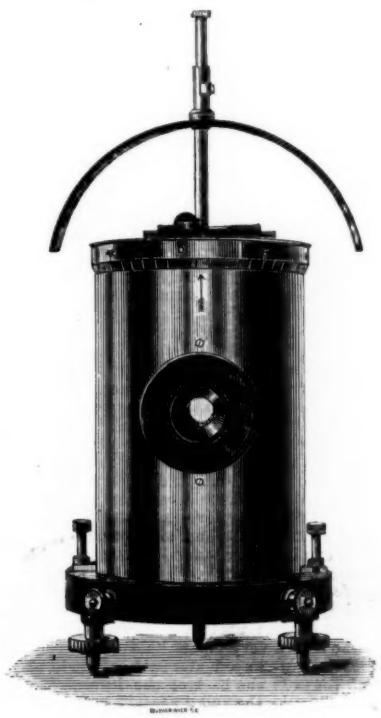


Fig. 1.

When, however, it is in good working order, there is so much satisfaction in working with it that one returns with reluctance to the use of other instruments. It is needless for me here to point out the various ways in which such galvanometers are now used, practically and experimentally, nor does it exactly come

* Read before the Physical Society, March 10th.

within the scope of the paper to enumerate the uses to which this instrument can, and probably will be, put, in connection with the great extension of electrical engineering which is now taking place.

In the instrument before you it has been my aim, while preserving to the full the sensitiveness usually obtained in good laboratory instruments, to simplify and alter the construction, and thus fit it better for every-day needs, without at the same time diminishing its efficiency for the work with which it is now more particularly associated. It is constructed as follows :—

Fig. 1 shows the instrument complete. The base is circular, and 5 inches in diameter. The case is of brass, its top being 6 inches above the base. The adjusting magnet, which is removed for carriage, rises 8 inches further. The instrument is thus very small and compact. The adjusting magnet works up and down on its rod, a slot in the rod preventing lateral movement. Lateral movement is provided for by rotating the top of the case, which is marked with degrees, so that the magnet can always be brought back to the same position again directly, if it is necessary to move it.

The spirit level or levels for setting the instrument are on the top of the lid. The case itself is provided with two L pieces at the bottom engaging in two screws with milled heads on the base. By giving them half a turn, and rotating the case slightly, it can be lifted off.

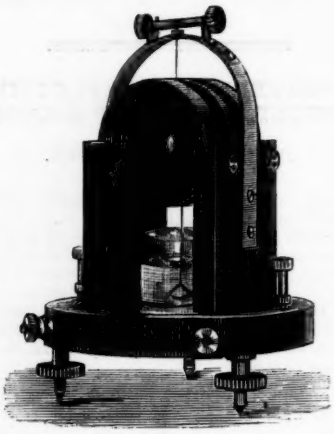


FIG. 2.

Fig. 2 shows the appearance of the instrument when the case is taken off. Rising from the base are two parallel uprights of ebonite, four brass rods pass up through these, holding them in their places on the base and forming the means of connecting the terminals with the wire on the bobbins. Further, there are four small thumb screws which will be seen near the top of the ebonite uprights, two on each. These screws pass through the brass rods I have mentioned and into the outside cheeks of the bobbins.

The shape of the bobbins themselves will readily be seen in the fig. The outside cheeks are left much thicker than the inside, and all the cheeks project about $\frac{1}{4}$th inch beyond the coils of wire. The lower halves of these projecting cheeks are cut away at the sides as can be seen in the fig., leaving the upper portions projecting so that the coils rest on the projecting portions on the ebonite uprights and slide exactly into their places. The cut-away portions of the thick ends of the bobbins are faced with brass plates to which the ends of the coils are soldered. The thumb screws above mentioned screwing into the brass plates complete the connections and hold the bobbins firmly in their places. Both bobbins can thus be taken out in a moment without disturbing the needle, there are no awkward connections to make or to get out of order, and if desirable several sets of bobbins can be made, wound with different lengths and sizes of wire to fit the same instrument which can be interchanged without trouble at any time.

Now we come to the needle. The suspension is of quite a different type from that usually employed. A brass hoop will be observed passing over the centre of the bobbins and screwed at either end to the ebonite uprights. The whole galvanometer is put in the lathe and a very small hole bored centrally through this brass hoop. A V-shaped slot is then cut in the brass hoop from the front towards the back of the instrument, the point of the V groove ending in the small central hole. About $\frac{1}{4}$ inch on each side of the hole two brass uprights are fixed: they are forked at the top and hold a little ebonite rod with milled heads at each end. One end of a silk fibre is attached anywhere on this rod, the other end is attached to the needle. The fibre may be a yard long if desired, the ebonite rod is then turned, winding the fibre round it until it, the fibre, is about the right length, and then the ebonite rod is slipped into its place. The fibre then if it is wound the right way round the rod at once automatically centres itself, and by rotating the rod the needle can be set exactly. By this means a long supension is secured, and if it is desired several rods and needles can be kept for different purposes. Say one with damper for general use, and a finely-balanced astatic one for delicate testing, a ballistic needle for condenser work, &c. When the instrument has to be carried about a great deal spare needles ready suspended can be kept and be put in, in a minute at any time, should an accident happen. If the suspension of a needle does break it is often at a critical moment when time is important. To replace it as usually suspended is, as a rule, a long and tedious job; much valuable time may therefore be sometimes saved by the use of a suspension of this character. It will readily be seen that attaching a new fibre is a very simple and short operation as compared with that necessary with the ordinary type of instrument. The needle itself consists of a stiff aluminium wire carrying the magnets and mirror.

For all ordinary testing work I prefer to bend the lower end of the aluminium wire round into a loop and flatten it out. This makes an excellent damper; it is sufficient to prevent long swinging and annoying vibrations without rendering the instrument dead and sluggish. This damper works in a little glass jar fixed in the base of the instrument. The jar has its edges turned over to prevent the liquid being spilled when carried about. It is, of course, easy to add a second pair of coils on the same principles as the two in the instrument before you, should it be desired, but a constant of 1 degree deflection with 1 volt through 1,000 megohms can easily be got with a single pair of coils, which is more than sufficient for most purposes.

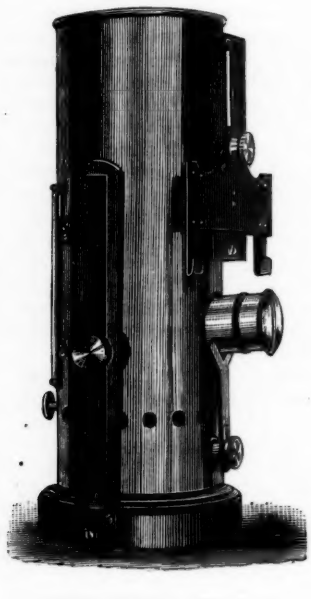


FIG. 3.

In using reflecting galvanometers a lamp and scale are required. All who have had experience in working with such instruments know that there is often as much trouble with the lamp and scale as with the galvanometer.

In the lamp and scale I have here I have tried, while securing the maximum efficiency, to reduce the whole within as small a compass as possible. The lamp itself consists of a copper tube about 12 inches long and 4¼ inches in diameter. The bottom of the tube forms the reservoir, the top portion acting as a screen. This tube is supported by guides at the sides attached to a metal base, and which permits of the lamp being moved up and down through a total range of 6 inches.

In order to fill the lamp easily, a funnel is provided in the top of the reservoir with a tube attached which reaches nearly to the bottom of the reservoir. In this way the lamp can be quickly and cleanly filled, and there is no need of a screw stopper to keep the paraffin from spilling or evaporating.

Most essential points in the construction of a lamp are that the longer axis of the flame and the axis of the lens or slot should coincide, and further that the intensest part of the flame should be opposite the centre of the lens. In this lamp, by prolonging the rod carrying the milled head for adjusting the wick and causing it to fall in a slot in the tube just below the door at the back, the longer axis of the flame is always kept in the proper place. Again, the height of the burner is carefully adjusted to be right when the lens is in a horizontal position. Further, to allow the lamp to be used in various positions and with different instruments, the lens tube is made adjustable through a considerable angle, its axis of rotation being the centre of the flame. In this way a beam of light can be thrown upwards or downwards, as well as in the horizontal direction. This is in working often a matter of great convenience.

For use with the lamp I have arranged a specially portable scale and shade. The scale itself consists of ½ a metre, divided into millimetres. It is mounted on a thin board, as usual; this board

is attached to a shade of the same length by long hinges. The whole is then cut through the middle, and a hinge fixed on the back of the shade. By this means the whole folds into half its length. Guides are fixed on the back of the scale, which engage in lock fixed to a cross piece on the front of the lamp, so that the scale slides easily backwards or forwards, and means are provided for raising or lowering the scale by itself, which is often convenient.

For carrying about or putting on one side a box is arranged to take both galvanometer and lamp, with room for shunts and other accessories. The size of this case is rather less than is required for the ordinary pattern of lamp alone.

The maker of the instruments is Mr. J. J. Hicks, of 8, 9 and 10, Hatton Garden.

REVIEW.

A Pocket-book of Electrical Rules and Tables. By JOHN MUNRO and ANDREW JAMIESON. Fifth Edition. London: Charles Griffin and Company.

The careful revision to which this most useful work is subjected as each succeeding edition is brought out very naturally enhances its value. Naturally the additions, &c., which have been made are chiefly in the domain of electric lighting. Thus we have numerous additional details concerning dynamos, and the fitting up, arranging, and working of accumulators. Without going through the book in detail, it would be impossible to point out the changes which have been made; but those who make use of the work (and there are few, if any, electrical engineers who do not possess copies we should imagine) will find much matter added which will be of use to them.

NOTES.

Mill Lighting.—The newly-erected Spry Mills, Lifton, Cornwall, are successfully illuminated by means of the electric light.

Paris by Electric Light.—The Municipal Council of Paris has not given up the idea of lighting the gay city by electricity, and the question is being taken up with great earnestness in view of the forthcoming Exhibition. A report on the subject has been handed in by M. Lyon Allemand to the Council, and it is proposed in that document that there should be a large municipal machine-room under the Central Markets, with wires extending through the metropolitan sewers to the main boulevards and other important arteries. The first experiments with it were made on the Place du Carrousel, near the gate of the ill-fated Tuileries, the very spot where, by a remarkable coincidence, modern gas supplanted, in 1819, the old lamps hung on lines and worked by means of pulleys.

Electric Lighting in Bedford.—The electric light has just been introduced by Messrs. J. Bull & Co., jewellers, High Street, Bedford. There are 11 lamps of 16 C.P. distributed about the shop and window. The motive power is obtained from Messrs. Bacchus and Ison's existing plant, which has run very successfully for nearly a year and has now been enlarged in consequence. Messrs. Bacchus and Ison have replaced their former arc lamp by a "sunbeam" of 400 candle-power, over the front of the shop, the light from the latter being absolutely steady. The above work has been executed by Messrs. Christy, Son, and Norris, electrical engineers, of Chelmsford, who erected the original plant, and also those at Messrs. W. J. Rogers's flour mill and Mrs. Grimshawe's, Goldington Grange. Several other tradesmen, having inspected Mr. Bull's installation, are talking of adopting this system of lighting.

The Spiel Engine and Electric Lighting.—Mr. G. V. Fowler, of the firm of Fowler, Lancaster & Co., Birmingham, has recently had his private residence at Longbridge, near Warwick, tastefully fitted throughout with the electric light, employing for the purpose a Spiel petroleum engine driving a dynamo which charges a set of E.P.S. accumulators, from which the current is distributed over the premises by the manipulation of a switchboard. The engine is of 2 H.P. nominal, but works up to more than 3½ H.P., and the small amount of attention it requires is given by a boy of 15. As the oil tank holds sufficient for four hours the engine can be safely left for that time after filling up the tank. The dynamo is a Fowler-Lancaster 3-unit machine, shunt-wound, embodying some recent improvements. The use of accumulators renders it unnecessary to run the engine at night or on Sunday, and an automatic cut-off prevents any evil result arising from any accidental fall in the E.M.F. of the dynamo or any stoppage of the engine. A local paper in noticing the installation remarks:—"In the daytime the accumulators can be charged, and by always having a day's supply in hand, a temporary breakdown in the machinery would not involve the house in that total darkness which on one or two occasions has been found so inconvenient in Leamington." The same journal goes on to make the following comparison:—"Each of the gate lamps (at Mr. Fowler's) gives 50 C.P., or rather less than the 3-light lamps in Leamington, and yet from their position and casing they appear to give a light better diffused. The lamps are situated at the top of the supporting columns, and throw no shadow. The casing is just sufficiently frosted to hide the shape of the lamp, ... and what it loses in the percentage of light it obstructs as compared with plain glass it gains in general appearance and in diffusion of the light."

Kensington Vestry and Electric Lighting.—At the meeting of the Kensington Vestry on the 7th inst., a communication was received from the Secretary (*pro. tem.*) of the Notting Hill Electric Lighting Company, Limited, inquiring whether it is probable that the Vestry will shortly notify its assent to the undertaking of the company, as not only the undertaking, but the residents in the district generally, will be prejudiced by delay; another from the Kensington Court Electric Lighting Company, Limited, called attention to the serious prejudice caused to the company by the delay in dealing with its application for powers to lay underground mains through an extended area in this parish, and asked that it might be notified with the least possible delay, especially as the whole question has still to be received by the Board of Trade.

Bath and the Electric Light.—At the last meeting of the Bath Town Council the question of electric lighting cropped up in connection with a motion which was submitted, recommending the repair of the chandeliers in the banquetting room at the Guildhall at a cost of £30. Complaint was made as to the abominable degree of heat which was evolved from the chandeliers, and Mr. Jolly proposed that no expenditure such as that proposed should be incurred at present, but that the Borough Property Committee should be instructed to obtain plans and estimates for lighting the Banquetting Room, the Council Chamber, and the Sessions Court by the electric light, using the motive power of the water now running to waste in the river, the property of the Corporation, and report to the council at the next meeting. He pointed out that at present there was running to waste a motive power valued at £2,000, and that would suffice to turn a turbine which would produce sufficient electricity to light the Guildhall and the markets. A saving might be thus effected, and a more comfortable atmosphere brought about in the hall. After a short discussion, during which the electric light was favourably spoken of, one member, however, expressing an opinion that the council ought not to expend £3,000 to pioneer its introduction, the amendment was lost by 12 votes to 16.

Ship Lighting.—Two fine steamers are in course of completion at the yards of Messrs. J. and G. Thomson, Clydebank, for the Inman and International lines. These vessels, the *City of New York* and *City of Paris*, are supposed to be finer in every way than any which have preceded them, and the fittings and decorations are on a gorgeous scale. The ships throughout are lighted by electricity, more than a thousand incandescent lamps being provided in each case. There are two engines, so that should one break down the other is available to prevent darkness in any emergency. The whole apparatus has been supplied by Messrs. King, Brown & Co., Edinburgh.

Bournemouth and the Electric Light.—The newly-formed electric lighting company at Bournemouth is losing no time in commencing operations, and has already issued orders for the necessary plant. At the last meeting of the Bournemouth Commissioners the Roads and Works Committee reported that before replying to a letter from Mr. Shakell, the secretary of the company, requesting permission to open the roads for the purpose of laying down the mains, it had asked for full particulars and plans to be supplied. A letter was also stated to have been received from Messrs. Phillips, Harrison and Hart, offering to light the pier and pleasure grounds with the electric light at costs varying according to the method adopted, and on the recommendation of the Lighting Committee, it was resolved not to entertain the question at present. A further letter having been read from the said firm, announcing their intention to apply for an electric lighting license for the district of Bournemouth, which, it was pointed out, would give them the power to open the roads, &c., it was resolved to discuss the matter at a future meeting.

Central Station Lighting in Berlin.—The first central station in which accumulators are used has been recently started in Berlin, at No. 37, Neue Friedrich-strasse. The plant consists, according to *Industries*, of two 45 H.P. Babcock and Wilcox boilers (manufactured by messrs. Schmidt, of Küstrin), two steam engines of 35 H.P. each, and two 18 kilowatt dynamos. The current is not supplied direct from the dynamo, but from a battery of flat tray pattern Khotinsky accumulators, each cell having 600 ampère hours' capacity. The principal customer at present is a restaurant situated under the elevated railway, and a total of 500 lamps is now installed; but applications for the light from neighbouring places have been received, and to provide for the extension the battery boxes have been made deep enough to admit additional plates, by which the capacity can be increased by another 600 ampère hours. The lamps used are 150-volt Seel lamps, and the total cost of the central station and mains was £3,500, that is, at the rate of £7 per lamp fixed.

Lord Thurlow's Prophecy.—The *Gas World* characterises the prophecy of Lord Thurlow that not a gas lamp will be left in our streets four years hence as "one of the most audacious predictions that ever fell even from the lips of a chairman of a struggling electric light company." It says:—"Electric lighting men have made many wild and extravagant statements during the past eight or nine years, but we do not recollect any equal to this. The prophecy is so manifestly absurd that we are led to wonder whether Lord Thurlow was in his right senses when he uttered it, or whether he thought he was talking to a number of fools who would believe anything. Apart from any other considerations, the available engineering resources of the country would be unable to achieve such a Herculean task in the time."

Lighting of Botanical Gardens.—Arrangements have been made for lighting the Royal Botanical Gardens, Old Trafford, Manchester, three evenings a week with the electric light during the forthcoming season. Tho season will open on May 18th, being the Friday before Whitsuntide.

Electric Lighting in Eastbourne.—The Eastbourne Electric Lighting Company has recently increased its plant to meet the growing demands for current. Formerly three 50 H.P. engines sufficed as motive power, but a 300 H.P. engine now replaces them. There are now 1,400 incandescent and 30 arc lamps—16 of the latter being on the Parade—in use in Eastbourne. The greatest advances have been made since Mr. H. W. Kolle assumed the management two years ago; he has been ably aided by Mr. Lowrie, the consulting engineer to the company, and Mr. Hall, the electrician.

Electric Light in Havre.—The Municipal Council of Havre is prepared to receive tenders for the establishment of a central electric light station in that town. The public lighting will comprise the Rue de Paris, Place Gambetta, Place de l'Hotel-de-Ville, Rue Thiers (so far as the Rue du Champ de Foire), Rue des Drapiers, and Rue Royale. This lighting will be effected either by arc lights or incandescence lamps, and the contractor must be prepared to instal private incandescence lighting along the routes above-mentioned. The cables must be well insulated, and are to be placed in underground conduits. Particular attention is called to the following points:—1. What price will the contractor charge for private lighting? 2. Will the contractor undertake the public lighting, and at what price? 3. What yearly tax will the contractor agree to pay to the town? The tenders must be sent in to Mons. A. Rispal, Mairie du Havre, before the 31st inst.

Tunnel Lighting.—We read in *Industries* that the Hoosac tunnel is being fitted up with the Westinghouse transformer system. 1,250 25-C.P. lamps will be fixed to the side walls of the tunnels; the conduits are of ¾-inch Canadian pine, seasoned three years, soaked in a composition of tar and oil, and painted with tar outside previous to laying in the trench. About 60 miles of conductors will be employed for mains and lamp connections.

The Electric Light at Dover.—There is a prospect of the electric light being introduced into Dover. Messrs. Laing, Wharton and Down have made a proposal to establish a station from which a service can be supplied for the lighting of private and public premises, and for street lighting purposes. The matter came before the Dover Corporation this week, and elicited a somewhat lively discussion, several of the members of the Corporation being well-known gas shareholders, one of them a director of the local gas company. After some discussion, in which the Mayor evidently showed an inclination to favour the introduction of the light into Dover, the subject was allowed to stand in abeyance until it had been seen what were the results of the experiments it is proposed to make on The Lees at Folkestone, where it is stated that not only would the town derive the advantage of an improved light, but that it could be done at a cheaper rate than the cost of gas, at present used. Notwithstanding the proverbial Conservatism of the town of Dover, the proposal to introduce the electric light has already met with very considerable favour amongst the tradesmen and inhabitants, many of whom declare that if a station is established they will make use of the light.

Electric Lighting at Southampton.—Experiments are now being conducted at Southampton, under the supervision of the borough surveyor (Mr. W. B. G. Bennett), with the electric lighting plant which was made use of last year in connection with the celebration of the Queen's Jubilee. Mr. Bennett's object is to ascertain how far the motive power in connection with the refuse destructor at the Corporation Works, Chapel, can be utilised for lighting the town. The result of the experiments, which, so far, have been satisfactory, will be brought under the notice of the Corporation, when an interesting debate on electricity *v.* gas may be expected.

Electric Light Legislation.—A well-written article on this subject, which will well repay perusal, appeared in the last issue of *Industries*.

The Telephone in the Dumfries District.—A public meeting was recently held in Dumfries for the purpose of considering the proposed introduction of a telephonic exchance for Dumfries, Maxwelltown and district. Mr. Bennett, of the National Telephone Company, addressed the meeting. Sufficient promise has been made to ensure the speedy realisation of the scheme.

Bacup and the Telephone.—A representative from the Lancashire and Cheshire Telephonic Company met a committee of the Bacup Town Council on Wednesday afternoon to discuss the proposed extension of the telephonic system to Bacup. Ultimately it was arranged that if twelve subscribers could be got at a yearly rental of £12, the company would extend the system. Bacup and Clitheroe are the only boroughs in Lancashire not connected with the telephonic system.

Telephone Extension in Ireland.—The National Telephone Company intends to open communication between Belfast and Larne. The company has now over 450 connected services in Belfast, Lisburn, Newtownards, and Holywood, and that the other proposed extensions include Lurgan and Portadown, the ultimate object in view being the establishment of communication between Belfast and Dublin and all the intermediate towns.

Local Authorities and Telephone Wires.—The Western Counties Telephone Company, which has been prevented from extending its trunk line to Dorchester owing to a dispute with the municipal authority as to the rights of the latter to control the erection of wires, has practically consented to recognise such rights. At a meeting of the Council last week, a draft agreement was presented, and subject to certain alterations, was approved.

Cupar and the Telephone.—The National Telephone Company has now completed its arrangements in the Cupar district, and will within a few days open the telephone exchange, under the management of Mr. James Dewar, at the Crossgate. The exchange will have communication in the north with Dundee, Arbroath, Forfar and Perth, and in the south with Markinch, Leven, Kirkcaldy, Dunfermline, Stirling, &c.

Lincoln and the Telephone.—At the meeting of the Highways Committee of the Lincoln Town Council on February 22nd, Mr. O'Donnell, agent of the National Telephone Company, attended, when it was resolved that the council be recommended to enter into an agreement with the company for the purpose of carrying into effect arrangements with respect to the establishment of a telephone exchange in Lincoln and the fixing of wires over the highways. Mr. O'Donnell attended the meeting of the council last week, and took exception to the stipulation that plans should be submitted seven days before commencing the work, stating that it would put the company to unnecessary trouble. Mr. Page said it was no use presenting the plans when the work was done. The agreement, as recommended by the committee, was confirmed.

Telephones and the Small Pox.—Blackburn is suffering under an epidemic of small pox, and the telephone has been called in to aid the authorities in coping with the visitation. The Health Committee on Saturday resolved to have telephones fitted up at the hospital and at Finnington. In the case of the latter no risk was involved, but it was different with the former. The local manager of the Lancashire and Cheshire Telephone Company appealed to his men for volunteers, and the duty was cheerfully undertaken by Mr. Arthur Williamson, senior, instrument fitter, and Wireman Aspden. Every possible precaution was taken to preserve the men from infection.

The Telephone Companies.—The London correspondent of a Manchester paper states that in order that they may not be taken by surprise and extinguished single-handed, the telephone companies have made up their minds to combine and to form one powerful corporation. "Negotiations on the subject," he says, "have been for some time pending, and I believe that definite terms of agreement have now been concluded. It has long been an open secret that the Postmaster-General contemplates laying hands upon the telephones, and the companies are naturally anxious to obtain the highest possible price for their property. Amalgamation will, moreover, give them an immediate benefit, by enabling them the better to undertake the work of laying trunk lines between London and the principal provincial towns; but before this can be done certain concessions are needed from the Post Office, and for these Mr. Raikes will very shortly be asked."

The Telephone in the West.—The Western Counties Telephone Company is ensuring a capital connection from Bristol into South Wales, and has commenced operations in Devon with the ultimate object of through communication with the principality. Plymouth and Exeter are both being covered with wires, and Newton, Torquay, and Paignton have been joined in telephonic combination. The latest move is to bring the ancient borough of Totnes within speaking distance of Torquay, and it will not be long before this will become an accomplished fact. A trunk line is in course of erection, and soon Newton, Torquay, Paignton, and Totnes will be as one for purposes of communication.

Imperial Telegraphs.—Mr. J. Henniker Heaton, M.P., who has during the period he has sat in Parliament taken special interest in questions relating to intercommunication between the mother country and the Colonies, read a paper on Tuesday evening, at the Royal Colonial Institute, on "The Postal and Telegraphic Communication of the Empire." He stated that the telegraph charges to New Zealand were 10s. 6d., to Australia, 9s. 6d., to the Cape of Good Hope, 9s. 11d. per word, while to some other places the rate was as high as 27s. The Imperial and Colonial Governments, in his view, should unite to acquire all the existing imperial telegraphs, and to construct what other lines might be deemed necessary. This seemed at first sight a very formidable undertaking, but the difficulties disappeared on close examination. The existing companies which would be embraced in any such scheme have a total outstanding capital of about £10,500,000. This meant that the cost of the cables must be set down at £300 a knot, or about double the price at which entirely new cables could be laid down now.

Telegraph Extension in the West Highlands.—Arrangements are now in course of progress for the extension of the telegraph system to the islands of Tiree and Coll. The want of the means of telegraphic communication between these islands, the former especially, and the south has been very much felt of late years. Constant complaints have for a long time been made that the fishing industry in these islands was injuriously affected by the want of means of communication with the mainland. It is understood that the long deferred action that is now being taken is at the instance of the Scottish Fishery Board. The wire will be carried overland from Tobermory to the west side of Mull at Calgary Bay, a distance of 15 miles, then a cable will extend to Arnagour Bay, Coll. The wire will then be carried down to the south end of the island, and a connection with Tiree formed across the narrow sound that separates the two islands by another cable. The work is expected to be completed by the end of April.

Enterprising Evening Journalism.—The *Manchester Evening News* is now connected with London by a private wire, the first which has been established between the Metropolis and the chief office of a provincial evening newspaper.

Australasian Cable Rates.—On January 23rd, Messrs. W. H. Taylor, W. Warren, and Squires, representatives of the Eastern Extension Cable Company, attended the Intercolonial Postal Conference at Sydney, and explained Sir John Pender's proposals for the reduction of the European cable rates to 4s. per 10 words on condition that the Colonies guaranteed for the next 13 years an annual revenue equal to the average yearly earnings of the cable for the three years ended in 1886. The average receipts were stated to be £185,000, and the earnings at 4s., estimated upon the present traffic, £80,000, leaving £105,000 a year to be paid under the guarantee. The company, however, is willing to accept a fourth of the risk under the guarantee, reducing the liability to the Colonies to £78,750. The representatives of the company were questioned regarding details, but the delegates did not commit themselves to any expression of opinion. Mr. Squires was asked for particulars relating to the New Zealand cable dispute, and figures were produced by him to show that since the subsidy of £7,500, a loss of £15,000 had been sustained in the working of the line. The company was prepared to sell the line for £120,000, and guarantee its maintenance for a period to be fixed, or to reduce the rates if the Governments would guarantee the company a stated yearly revenue, or if they would hand to them the land charges of 6d. per word collected by the Colonies through which the messages are sent. Failing the acceptance of any of these proposals, the company would have to adhere to the present rate of 8s. 6d. per 10 words. The whole question of cable subsidising came under discussion, and it was decided that the Colonies should contribute in proportion to population to the subsidies now paid to the Eastern Extension Cable Company, and that a like division should be made with regard to the cost of the Tasmanian and New Zealand cables; that a survey should be made of the route of the proposed Canadian cable at the joint cost of England, Canada, and Australia; and that the question of the reduction of the present cable rates should be considered by the different Governments interested. It was resolved that telegrams marked urgent should be given the preference on payment of a special fee.

The Pacific Cable Scheme.—*Colonies and India* states that Mr. Owen Jones, C.E., one of the London directors of the Pacific Cable Company, has arrived in the colonies for the purpose of endeavouring to obtain from the several Governments a subsidy towards laying a telegraph cable between Vancouver Island and Australia. The Intercolonial Conference has already approved of a survey, but the idea, although adopted, was not by any means unanimously approved. Mr. Jones states that the Canadian Government has expressed its readiness to make a very liberal contribution towards the construction of an American-Australian cable by way of Honolulu, and the Hawaiian Government has voted £4,000 annually for 21 years towards the same object. The Canadian Pacific Railway Company having agreed to deliver messages from Great Britain to Vancouver at the rate of 8½d. per word, the Pacific Cable Company proposes to forward them on to Australia, the inclusive rate from Great Britain to Australia to be something under 5s. a word, with press rates proportionately low.

A Telephone Exchange for Godalming.—A meeting of the inhabitants of Godalming was held in the Masonic Hall, Godalming, on Tuesday, the 6th inst., to consider the proposal of the Equitable Telephone Association to establish a telephone exchange in Godalming and district. After the meeting had been addressed by Mr. A. A. Campbell-Swinton and Mr. Macpherson Grant, of the Association, the following resolution was moved by Mr. E. Pullman, of Godalming, and carried *nem. con.*:—"This meeting considers it, in order to keep with the times, desirable to establish a telephone exchange in Godalming, if a sufficient number of subscribers can be enlisted."

Red Sea Cables Broken.—Seven weeks ago one of the Suakim cables broke down, and the Eastern Telegraph Company's ship *John Pender* has been ever since endeavouring to repair it, but has met with unusually severe weather. Last week the other Suakim-Perim cable broke down, and the *Mirror* sailed from Malta on Saturday for Suakin to take charge of the work of repairing that cable. There is at present no communication with Suakim.

The Berlin Telegraph Office.—Friday last will long be remembered as the busiest day on record at the Central Telegraph office of Berlin. No fewer than 36,615 telegrams, containing together 1,115,551 words, were despatched to all parts of the globe, and in different languages. During the busiest hours of Friday last, no fewer than 346 telegraphists were at work at the same time in the great instrument room of the Central Telegraph office, and 230 instruments were operated.

Fire Insurance Rules.—A correspondent writes:—At length the blow has fallen, and we have now another set of fire insurance rules! We have to-day seen a copy, and we presume that now not only will the telegraph engineers get out a set, but every individual insurance company will follow. What are contractors to do then, what will the public think? Surely if the society had only been content to adopt the well known Phœnix rules, and embody them as their own (of course acknowledging their origin), all this trouble might have been averted. Who can tell the amount of damage that will be done to our industry through the obstinate and irresponsible action of our presumably representative society? If a poll had been taken of the society's members, or of the electrical trade, would not the verdict have been in favour of letting well alone and giving to the Phœnix rules (which certainly have the merit not only of priority but of secured success) the authority of the trade's society? These are burning questions, and certainly require the immediate attention of every electrical contractor.

Late Letters.—We have received communications from Messrs. Killingworth Hedges and E. Manville, the latter engineer to the Series Electrical Traction Syndicate, Limited. The first is on the subject of aluminium alloy for small fuses, and the other a lengthy and interresting dissertation on electrical propulsion. Both will appear in our next issue, together with a third which has just come to hand on the Swinton telephone intercommunication system.

The Willans Engine.—On Tuesday last Mr. P. W. Willans read a paper before the Institution of Civil Engineers on "Economy Trials of a Non-condensing Steam Engine." At the conclusion the author referred to an efficiency trial of a combined central-valve engine and Siemens dynamo, made for the Admiralty, at various powers. At the highest power the ratio of external electrical H.P. to indicated H.P. in the engine was 82·3 per cent. Taking the thermo-dynamic efficiency of the engine at 80 per cent., that of the combined apparatus would be nearly 66 per cent.

Obituary.—One of the very few remaining links with the pioneer electric-telegraph era has been severed by the death of Nathaniel John Holmes, which occurred last week at his London residence. Mr. Holmes was the friend and adviser of the late Sir Charles Wheatstone, and connected the West of Scotland, as well as many other parts, including the Orkney and Shetland Islands, with the great centres of civilisation by the electric telegraph.

Paris Exhibition, 1889.—The general meeting of intending exhibitors convened by the committee of the Society of Telegraph Engineers and Electricians, takes place on Monday next, the 19th inst., at the Institution of Civil Engineers, at 3 p.m. We understand that Mr. Aylmer, the honorary secretary in France, will attend the meeting in order to give any necessary information.

The Patented Appliances Company.—Mr. Chs. J. Caspers has undertaken the management of the Patented Appliances Company, which has been established at 17, Coleman Street, E.C., for the purpose of introducing, selling, or working suitable inventions, relating to improvements in all kinds of mechanical appliances. The company has now in hand a fire alarm apparatus for introduction in this country.

Failure of Edison Tubes.—We learn that in Milan the Edison tubes laid down for the electric light installation have given a considerable amount of trouble owing to the very great leakage. It was found that this was due partly to a slight subsidence of the ground and partly to the inability of the tubes to withstand the heavy traffic. The electric lighting company is consequently removing all the Edison tubes and replacing them with insulated conductors laid in wooden troughs.

Electricity v. Steam Power.—The printing firm of Messrs. Van den Houten & Co., of New York, until lately employed a 10 H.P. engine for their presses, but owing to inefficient service, they decided to try an electromotor. The work is now being satisfactorily performed by a 7½ H.P. Sprague motor.

Ocean Currents.—On February 2nd last Mr. J. G. Buchanan, F.R.S., read a paper "On tidal currents in the open ocean" before the Royal Society. The portions of the paper which more particularly interest telegraph engineers are those dealing with the formation of shoals, the presence of currents at comparatively great depths, and the possibility of meeting a rocky bottom in unexpected situations. With reference to the last mentioned feature, Mr. Buchanan says:—"Much rocky ground is met with in the North Atlantic in depths of 1,300 and 1,400 fathoms, especially on the ridge which appears to extend through the whole length of that ocean. It is not unlikely that the summit edge of this ridge may be swept clean through the greater part of its length, and it must be remembered that the removal of sediment from one part of the ocean bottom means its deposit in greater abundance in others, especially in hollows in the neighbourhood of the ridge. Hence a sounding in 'ooze' or 'mud' in one position furnishes no argument against the trustworthiness of another sounding in the vicinity, and in equally deep water on 'rock' or 'hard ground.'"

The Electric Apparatus Company, Limited.—This company has now entirely closed its city offices. The following are now the only addresses:—4, Charing Cross, S.W., and 16A, Little Paris Street, Lambeth, S.E. Works, Arnold Road, Bow, E.

New York Electric Club.—How visiting Britishers' mouths must water when they find themselves the guests of the members of the Electric Club in New York! A mansion, elegantly fitted, lit by incandescence lamps, billiard rooms, parlours, lecture room, library, kitchen and restaurant, shoes blacked by electricity, an electrical stove, safe with electric lock, electric door opener, and so on, form the attractions and curiosities, and it is not surprising that the club is a favourite place of resort by the electrical talent, young and not so young, of New York and adjacent towns.

Electric Lighting Dispute.—We understand that a dispute has arisen regarding the installation partially fitted by the Maxim-Weston Company at Messrs. Crisp and Co.'s, Holloway. The contractors refuse to carry out the contract in accordance with the specification, and have issued a writ for £1,500, which Messrs. Crisp decline to pay until the installation is satisfactorily completed. The above sum, we may add, was the estimate for an installation of 40 arc and 300 incandescence lamps fitted with engine and boiler power complete. Is not this another example of the cutting down tactics of this now famous company?

The Liverpool Electric Supply Company, Limited.—In 1883 the Liverpool Electric Supply Company, Limited, was formed, apparently as a sort of tentative effort to give the electric light a permanent local home. The experiment has succeeded. The orignal capital was £10,000, but the business expanded and the capital was increased to double that amount. At the meeting last Monday the directors agreed upon a dividend of 7 per cent. Under these circumstances it is not surprising to note that the company has decided to make its business more commensurate with the requirements of the city. To this end it is increasing its capital to £200,000, including the shares to the value of £20,000 already subscribed, and it intends to supply the electric light to all who seek it within a very wide area, comprising the more important residential parts of Liverpool as well as the great business centres. It is arranged also that the supply shall be by day and night at a regular fixed charge, measured by meter. There has been a supply station in Rose Street for four years, and a second station has recently been started in Tithebarn Street, while a third and more important one is approaching completion in Harrington Street.

Trade Unionism.—Messrs. Crompton have been informed that it is the intention of the Trade Union not to allow piece work to be introduced into any of the new trades, such as they consider electrical engineering to be, and under these circumstances they state that they have no option but to part with such of their men as are members of the Union. This question is of considerable interest to the whole of the electrical engineering trade.

Non-Magnetic Watches.—An article appears in the *Journal of the Franklin Institute*, by Prof. Edwin J. Houston, on "Paillard's Non-Magnetic Compensating Balance and Hair Spring for Watches."

The Weather and the Wires.—Heavy falls of snow, and high winds, have prevailed intermittently in different parts of this country during the past week, but we do not hear of any great amount of damage to overhead wires.

At Brighton on Sunday the electric communications were interfered with owing to the storm, and at the Chapel Royal the electric light was suddenly extinguished at the evening service. The gas was quickly lighted in the chancel, and in the course of a few minutes the electric light was turned on again. At Portsmouth some injury was done to the telegraph wires, communication being cut off with the Isle of Wight. There were also a few cases of interruption further west.

In America the weather has been exceptionally severe, and the wires have fallen right and left round about New York. The cost to the Western Union Telegraph Company by the damage done to its wires is estimated at half a million, but will probably be a million dollars. Wires feeding the currents to the electric arc lights dangled across the streets, and pedestrians dodged under them as best they could. During Monday night the electric lights were not visible in some quarters. Urgent messages to Boston were sent first to London by the Commercial Cable, and thence retransmitted. Less severe storms were experienced in the West and South, and the *Standard* correspondent thinks the destruction done will probably have an important effect in hastening the adoption of underground structures for wires and trains.

Switches.—Messrs. Sudworth and Falkenstein have patented an improved method of attaching the caps or covers of switches to their bases so as to form an airtight joint. A sample in serpentine marble which we have now before us commends itself to our admiration. No small screws are employed nor does the top screw on; an India rubber ring, such as we spoke of in connection with the lamp protector illustrated in our issue of January 20th, is the sole means of securing the cover to the base, and the idea appears most excellently adapted to the purpose.

New Edison Lamps.—The new high economy lamp of the Edison Company, of America, is said to carry with it a saving of one-third the power required for the former style, and whereas the company formerly guaranteed 8 to 16 candle-power lamps to the mechanical horse-power, they now guarantee 12 for an expenditure of the same power, or 15 to the electrical horse-power. The old plants of the company are being rapidly fitted with the new lamp. The new 16 candle-power Edison lamps range from 90 to 125 volts and require only $3\frac{1}{10}$ watts per candle-power. A 100-candle lamp ranges from 90 to 125 volts, requiring a power of $3\frac{1}{10}$ watts per candle-power. A lamp which the advances of the storage battery art has called into being has been specially constructed, being of comparatively low E.M.F. (60 volts) and requires only $2\frac{1}{2}$ watts per candle-power. The Edison Company is now also making a series of lamps of similar economy for battery purposes, but running from 20 to 40 volts and from 10 to 32 candle-power. A spiral lamp is used in connection with Edison central stations. It is of high resistance, and requires 150 volts to bring it to incandescence. When, therefore, it is run at 110 volts it gives but a dim light, and this is what is desired, the lamp being intended for a night lamp, in bedrooms and other places where only a small amount of light is desired.

Royal Meteorological Society.—At the ordinary meeting of this society, to be held by kind permission of the Council of the Institution of Civil Engineers, at 25, Great George Street, Westminster, on Wednesday, the 21st instant, at 7 p.m., an address will be delivered by the President, Dr. W. Marcett, M.D., F.R.S., on "Atmospheric Electricity," illustrated by experiments; after which Mr. G. J. Symons, F.R.S., will make a short communication on "The non-existence of Thunderbolts; elucidated by accounts of searches after them and the exhibition of specimens." The meeting will then be adjourned, in order to afford the fellows and their friends an opportunity of inspecting the exhibition of apparatus connected with atmospheric electricity, including lightning conductors, photographs of lightning, and damaged objects, and of such new instruments as have been invented and first constructed since the last exhibition. The exhibition will, at the request of the Secretary of the Institution of Civil Engineers, be open in readiness for their meeting on Tuesday evening, the 20th instant, and will remain open till Friday, the 23rd instant.

Technical Education in the Middle Temple.—A meeting of a very interesting character took place in the Parliament room of the Middle Temple last week. Some weeks ago the Treasurer of the Inn for the present year, Sir Henry James, submitted to the Benchers a plan for affording to the students instruction by means of lectures upon subjects not strictly of a legal character, such as mechanical science, electricity, chemistry, and medical jurisprudence. The Benchers having given their approval to the proposed plan, it was on Tuesday afternoon announced to the students. Sir Henry James, who was accompanied by Mr. Michael, Q.C., Mr. Macrory, and Mr. Morgan Lloyd, Q.C., briefly addressed the assembled students. He informed them that the object in view was to give them instruction in subjects the knowledge of which would be of great service to them in the practice of their profession. He announced that Mr. T. Aston, Q.C., and Mr. Moulton, Q.C., had most kindly volunteered to lecture upon mechanical science, chemistry, and electricity as applied to the industrial arts, while Dr. M. Tidy would deliver 12 lectures upon medical jurisprudence. The lectures will commence in Easter Term, examinations taking place, and prizes being given at the end of the year. The members and students of the other three Inns of Court were also invited to attend the lectures. The students, through one of their body, gratefully accepted the offered instruction, and proceeded to elect a small committee in order to co-operate with the Benchers in their laudable efforts on behalf of technical education.

Personal.—We understand that Mr. G. A. Mason, late general manager of the Consolidated Telephone Company, has taken premises in Birmingham for the purpose of manufacturing magneto bells, &c.

Paris Universal Exhibition, 1889.—It is arranged that a meeting shall be held at the Mansion House to-day, at the invitation of the Lord Mayor, to consider what steps shall be taken in order to secure a suitable representation of British manufacturing arts and industries at this important exhibition.

Sale.—On Monday next the sale of the Elieson Electric Company's plant at Macintosh Lane, Homerton, is advertised to take place. The goods may be viewed on Saturday next and on the morning of the auction, which is timed for 11 o'clock prompt.

We also call attention to another sale at Southwark, particulars of which can be seen on p. 4 of Supplement.

The Keighley Fire Alarms.—The gas engineer to the Keighley Corporation, in an official report upon the late fire and the failure of the electric-bells, says that it is very unfortunate that the contract for establishing a fire-alarm system has not been completed. The contractors' men have been at work at it daily for some time, and it appears they had part of it only together when this alarm was given. The result was that the whole of the brigade were not called.

The Gilchrist Lectures.—The fifth lecture at Cleckheaton, under the auspices of the Gilchrist trust, was delivered by Mr. Wm. Lant Carpenter. The subject was "Fifty Years' Progress in Telegraphy," and it proved of absorbing interest to a large audience. Practical experiments illustrating the subject were given by Mr. Woods, inspector of telegraphs of the Oxford district, who, by permission of the Government officials, was allowed to accompany Mr. Carpenter during his lectures in this neighbourhood.

Destructive Mill Fire.—The Osborne Mill, Chadderton, Oldham, was burnt down last Saturday, and damage to the extent of several thousand pounds was done. The fire originated in one of the upper rooms during the lighting up for work, and spread rapidly. A correspondent sends us this information with the remark that it would form an excellent text to write an electric lighting sermon on.

Hastings and Overhead Wires.—In dealing with some applications respecting overhead wires, the Town Council of Hastings, says the *Sussex News*, has lately shown much indecision. Telephone wires are at present very thick above the houses in the main thoroughfares, and two months ago the South of England Telephone Company applied for permission to erect two poles to extend its wires from the houses in High Street to the Hydropathic establishment in Old London Road. At the same meeting the Electric Light Company asked sanction to convey some encased overhead wires across certain streets from its works to the Grand and Palace Hotels. Both applications were refused, but at the next meeting a communication was received from the Board of Trade requesting the Council to endeavour to come to some arrangement with the Electric Light Company, and the result is seen in the rescinding of the resolution after some close voting. Had the resolution been retained, it is stated that a law suit would have ensued. At the last meeting a memorial was read from ratepayers and other telephone subscribers in favour of the application of the Telephone Company; this, too, resulted in the revocation by 13 votes to 8 of the former decision of the Council, who have now sanctioned the erection of the posts, subject to certain conditions.

Time Ball for Norwich.—Proposals are being made for the erection of an electric time ball at Norwich Castle.

The Society of Telegraph-Engineers and Electricians.—The next meeting will be held at 25, Great George Street, Westminster, S.W., on Thursday, March 22nd, when a paper on "Electrical Stress," by Prof. A. W. Rücker, M.A., F.R.S., and C. V. Boys, will be read.

Sham Electric Belts.—Says the *Provincial Medical Journal*: "The ELECTRICAL REVIEW has been doing good service in exposing the impostures connected with electric belts, and asks for the support of the medical press in its efforts. We fear the craze or fashion is beyond the pale of medicine to control, though we nevertheless gladly aid our contemporary, and substantiate, by observation and experience with these appliances, the charges made, that these belts, sold at high prices, are not worth the money. This is all we can do. The world, according to Carlyle, is made up of fools mostly. If £3 3s. or £5 5s. can be obtained for a piece of flannel and a few metal discs arranged in order there will always be enterprising *entrepreneurs* to pick up the offerings of individuals who are so easily duped. Medical men have in every age protested against this and other forms of quackery, but some of the people pass by the way and encourage the charlatans. The lay press publish long and expensive advertisements of various medico-electric appliances, and evidently the demand is equal to the supply. We regret this, as it tends to bring into disrepute true medico-electricity." In the same issue of the journal is an article by Mr. W. G. Steavenson, M.D., M.R.C.P., who is in charge of the electrical department at St. Bartholomew's Hospital, on "The General Practical Uses of Electricity in Medicine and Surgery," and in this article the quacks are again denounced.

NEW COMPANY REGISTERED.

Exeter Electric Light Company, Limited.—Capital £20,000 in £10 shares. Objects: To supply electricity for light, motive power or heat in and within a radius of five miles of the City of Exeter or any other place in England. Signatories: *W. Haton Ellis, J.P., 40 shares; *L. J. Kennaway, 20 shares; *Walter Pring, J.P., 20 shares; *C. J. B. Saunders, 20 shares; C. F. K. Roberts, 10 shares; J. Knell, 10 shares; H. W. Michelmore, 5 shares; *G. F. Truscott, Honiton, 20 shares. The signatories denoted by an asterisk are appointed directors. Remuneration, £100 for the first year, £150 for the second year, and in each year afterwards £50 on every £5,000, or fractional part of £5,000, of share, debenture or other capital of the company. Registered 9th inst., by Torr & Co., 28, Bedford Row.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Empire Telephone Company, Limited (formerly the Mechanical Telephone Company, Limited).—The annual return of this company, made up to the 5th November, 1887, was filed on the 1st inst. The nominal capital is £100,000 in 20,000 shares of £5 each. 9,153 shares have been allotted and upon 553 of these the sum of £2 10s. has been called, and upon 200 shares the full amount has been called. Upon 8,400 shares the sum of £42,000 is considered as paid up. The calls paid amount to £2,347 10s., and unpaid to £35.

A meeting of this company was held on the 28th January, when an account was given as to the manner in which the winding up has been conducted and the property of the company disposed of. The final winding up return was filed on the 1st inst.

Anglo-Portuguese Telephone Company, Limited.—A resolution was passed at a meeting of this company held on the 24th ult., increasing the registered capital of £50,000 by the addition thereto of £25,000 in £1 shares. The resolution was duly registered on the 1st inst.

Nightingale Automatic Electrical Machine Company, Limited.—The registered office of this company is now situate at St. Stephen's Chambers, Telegraph Street.

CITY NOTES, REPORTS, MEETINGS, &c.

The Pilsen-Joel and General Electric Light Company, Limited.

AN extraordinary general meeting of this company was held at the Cannon Street Hotel on Tuesday afternoon, under the presidency of Sir Rawson W. Rawson, K.C.B., chairman, for the purpose of considering a proposal of the board for a reduction of capital.

Mr. W. H. Trentham, the secretary, read the notice convening the meeting.

The Chairman said: When we met you in November I expressed a hope that there was an amount of profitable business before us which would enable us to recover to a certain extent the capital which had been placed in this company, and to yield a satisfactory dividend for the future to our shareholders. Each day has increased our sanguine hopes in that direction. We had hoped that the use of the electric light would have extended from the establishments in which it is now employed—trading bouses, private residences, and public buildings—to street lighting, where particularly lies our interest. But it is pretty clear that that part of the business is not likely to take a large extension for two or three years at least. Therefore, our object should be to aim at extending our business in the direction of private installations. Many of you must be aware that several companies are driving a considerable business in that direction, and we feel that we should be wanting in our duty to our shareholders and neglecting the opportunity which now presents itself, if we did not extend what we had begun in this direction, being confident that with the careful and economical management under which it is now conducted, we can derive a satisfactory profit for the money actually invested in our operations. We have now had six years' experience; half that period was under the old system and the old hopes of extensive business throughout the country in street lighting, when we spent money in provisional orders and extensive surveys, as well as in manufacturing operations, which has led to the expenditure of our large capital and to disappointment. As regards our lighting of private residences and trading establishments, our operations have proved most successful. For the last three years we have not had a single failure, a single difficulty, or a single complaint. Those who first took our lights have taken more of them. In Tottenham Court Road we have an opportunity for a large development of house and shop lighting. We believe, therefore, that we are acting in the interests of the shareholders in making a call to complete what we have begun, so that we may increase the dividend with which, unlike most other companies, we have been able for two years to pay—a mere trifle, certainly, but still better than a loss. The second point that I have to bring before you is the explanation of our proposal for writing down the capital of the company. Our patents originally extended over two kinds of lamp, the arc and the incandescent. Our interest in the incandescent has already been destroyed by the Edison and Swan Company establishing its claims in this country, and the value of the Gatehouse patent has already been written off. Then with regard to the arc, we have been in existence as a company now for six or seven years, and the patent upon which we have been acting must have been existing a year or two before that, so that about half the life of our patent has already expired. We feel that we are bound to take that into account in the estimate of our assets. We should not be justified in maintaining those patents at their original value year after year. We may establish a certain goodwill that may be very valuable to us before the patents expire, and we may be able to prevent others from using our patents simply because we may be able to make better lamps than anybody else; but as directors, we are bound to take into consideration what the value of those patents will be year after year during the next seven years. That being the case, if we have to write off those patents, now valued at £25,000, the rate for seven years would be £3,000 a-year. Under these circumstances, we do not feel that we should be able to pay such a dividend as would make it worth our while to continue the operations of the company. Our profits would be swallowed up in simply keeping up the nominal price of our patents; and for that reason we believe that it would be most advantageous to the company to take as the value of the capital the money that is available for making installations under the present system. It is of no use our having patents of which the public do not desire to avail themselves. We have found no large demand for arc lamps, and we do not see any chance for the next two or three years of their use extending. The demand now is for many incandescent lamps and a few arcs. We possess the advantage of being able to offer our customers one of the best arc lamps in existence, but we

are obliged to provide ourselves with incandescent lamps to satisfy their wants, and after maturely considering the matter, having no object in view but the interests of our shareholders, we believe that this is the best thing for the Company. If any of our shareholders can offer a better course, we shall be most ready to accept and act upon their advice. I move as a matter of form this resolution:—"That if an order of the court be obtained for confirming this resolution, the capital of the company be reduced as follows: (*a*) By reducing from £2 to £1 per share the nominal amount of the 3,517 shares of the company of £2 each, which have been forfeited, and are now unissued. (*b*) By cancelling, as being capital which has been lost or is unrepresented by available assets, the sum of £1 per share on the 24,483 shares of the company of £2 each, with £1 5s called up thereon, being the shares numbered 1 to 28,000 inclusive, with the exception of those mentioned above in clause (*a*), and the sum of £1 16s. per share on the 100 fully paid-up shares of £2 5s. each, being the shares numbered 39,351 to 39,450 inclusive. And that the memorandum of association of the company be modified so as to carry into effect this resolution." The effect of this resolution was to reduce the item of patents, &c., to £527, and the capital to £7,620.

Major Scriven seconded the resolution.

Mr. James Fyfe rose to oppose the proposition of the directors. He contended that the policy of the board had been to depreciate the stock and the shares of the company to an unwarrantable extent. The company had a good property, and the proposed capital would prove quite inadequate. No reliance could be placed in the management which had pursued the course which the directors had followed. Mr. Fyfe here startled the meeting by asserting that really there was no board in existence, and, upon an explanation being demanded, stated that the holdings of Major Scriven and Mr. Whateley were not sufficient to qualify them to sit on the board. An excited controversy followed, Mr. Samuels stating that the dividends of 8d. and 4d. which had been paid had practically, though not in the legal sense, been paid out of capital. As a result of the discussion, it became evident that the accusation of Mr. Fyfe was correct, the two directors named having inadvertently allowed themselves to become disqualified when the value of the shares was reduced in November last.

The Solicitor stated that an article of association provided for such a case of accidental disqualification, and all acts of the board up to that time were perfectly valid.

Mr. Fyfe moved an amendment to the motion of the directors, which the latter signified their willingness, in the circumstances, to accept. It was, "That this meeting be adjourned for a month; that a committee of shareholders, consisting of Messrs. Hopkins, Gwynne, A. Hutton and James Fyfe, be appointed to investigate the statements contained in the notice convening this meeting, to confer with the chairman and late directors, and to report thereon and generally upon the business of the company at such adjourned meeting; that the secretary be instructed to forthwith issue notices for a general meeting to appoint directors in the place of those disqualified; and that in the meantime the chairman and secretary be authorised to continue the business."

Mr. Hutton seconded this resolution, which was carried unanimously.

A vote of thanks to the chairman then brought to a comparatively amicable close what at one time threatened to become a stormy meeting.

The Eastern Extension, Australasia and China Telegraph Company, Limited.—This company announces that its accounts to December 31st last show, subject to audit, a balance of profit of £121,800, after payment of three interim dividends. The directors now propose to distribute, on April 26th, the usual dividend of 2s. per share, making a total dividend of 5 per cent. for the year 1887. It is also proposed to pay a bonus of 3s. per share, or 1½ per cent., making a total distribution of 6½ per cent. for the past year, against 6 per cent. in 1886. The balance of £53,000 has been carried to the reserve fund, which now stands at £620,000.

Direct Spanish Telegraph Company, Limited.—The directors on the accounts for the half-year ending December 31st, 1887, being submitted to them, decided, subject to their being audited, to recommend the payment of a dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend of 2½ per cent. (free of income tax) for the half-year upon the ordinary shares, making, with the previous distribution, 4 per cent. per annum for the year 1887.

The Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, payable on the 24th instant.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 9th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,881.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for week ending March 9th, amounted to £4,668.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this Society was held on Thursday, March 8th, Mr. E. GRAVES, President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, a paper was read by Mr. R. VON FISCHER TREUENFELD, on "The Present State of Fire-Telegraphy."

The object of the paper was to repeat and confirm what had been already established in the former one, read eleven years ago before the Society, in the hope that such repetition, based upon results of later date, will contribute to a more speedy adoption of electrical street fire alarms, which have long ago proved to be a great protection against the ravages of fires, and which yet only find their way into this country with an inexplicable and deplorable tardiness.

It was in 1880—three years after the utility of fire telegraphs, and the beneficial influence which such must have on the reduction of the number of "serious fires," were brought to notice by the author—that the London Fire Brigade began to introduce the fire annunciators or call points. Captain Shaw had in that year, in his twentieth report, the satisfaction of calling attention in his annual statistics to some specially interesting points, which became the beginning of a new era in the development of British fire telegraphs. He says:—

"A very important improvement has been effected this year by the establishment of six circuits of fire alarms with an aggregate of 40 call points, which very considerably reduce the distance to be run by persons giving alarms of fire, and consequently the time of our getting information. Although this improved mode of communication has not been established more than a few months, we have already received by means of it no less than 44 good calls. Unfortunately, however, we have also received 33 false alarms, many of which were without doubt wilfully raised. Thus it will be seen that the great advantage of the system has not been obtained without harassing the men and casting a doubt on the value of all messages received by these instruments. This has been the experience of all places which have adopted the system of street fire alarms; but I had great hope that in such a city as London we should have been free from an annoyance which, if persevered in, must eventually force us to discontinue what ought to be a very great improvement. I am still most unwilling to abandon this hope; and I think I may say, though not with any great confidence, that I begin to observe symptoms of a better state of things with regard to these useful machines for the future. . . . . The future of these street fire alarms must eventually depend to a very great extent on the inhabitants of London, who can render invaluable assistance in the way of protecting the brigade from being imposed upon by the tricks of foolish and evil-disposed persons, who have not enough intelligence to appreciate the gravity of the offence, with its possible effect of necessitating the abolition of a scheme, as yet only imperfectly applied, which promises to secure a more efficient and more extended means of protecting the metropolis from fire."

This report of Captain Shaw must have been exceedingly welcome to all who were firm believers in what was then for the first time officially recognised as "a scheme which promises to secure a more efficient and more extended means of protecting the metropolis from fire."

In that great hope Capt. Shaw has not been disappointed. Since the introduction in 1880 of the first 40 call-points, and during their gradual increase to 347, the percentage of "serious fires" has been reduced from 9 to 7—a result undoubtedly most beneficial to the protection of property, and which stands in close connection with, if it is not entirely caused by, the considerable reduction of the distance to be run by persons giving alarms of fire.

At the time of writing the first paper on "Fire Telegraphs," the proportion of alarm points to inhabitants in London was at an alarmingly low figure, and Capt. Shaw's official report gives the percentage of "serious fires" for the year 1876 as 11; whereas with the gradual increase of alarm-points, which in the year 1886 shows the more favourable figure of 1 : 6,880 inhabitants, the serious fires have already been reduced from 11 to 7 per cent. This is exactly what was predicted; and I do not hesitate for a moment to repeat what was said 11 years ago—that a perfect fire telegraph system, in which the proportion of alarm-points to inhabitants will become as high as about 1 : 2,000, instead of 1 : 6,880, as it was still in London at the end of 1886, would reduce the average percentage of serious fires to 4, which figure may be considered as an average minimum, but which a town like London, or any other British town of importance, ought to, and we have no doubt will, attain.

The serious complaint contained in the 1880 report of the Metropolitan Fire Brigade—viz., that 33 false alarms were received during the first year of the installation of the street call-points, and that these were without doubt wilfully caused by "evil-disposed persons" is certainly much to be regretted. But in this respect the hope which the Chief Officer expressed at the time—that London would be free from such annoyance—has also been realised, as the report of 1886 no longer contains any complaint as to wilful tampering with the alarm circuits.

The next point to be considered in this paper is, whether the increase of fire-engine stations, escape stations, of telegraph, telephone, and alarm circuits, and the introduction of call-points,

have produced an apparent decrease in the loss of life. It appears that the number of persons seriously endangered by fires in London during the 11 years from 1876 till 1886 was 1,844 persons endangered, of whom 1,437 were saved and 407 lost their lives. Of these 407 persons lost, 202 were taken out alive, but died afterwards in hospitals or elsewhere, and 205 were suffocated or burned to death.

The percentage of lives lost during the last eleven years very nearly amounts to two lives lost at every 100 fires; and this percentage has not been diminished by the introduction of fire-telegraphs, at least not in London, it remaining practically the same before and after the introduction of the fire-alarm circuits. This fact negatives the general belief that the fire-telegraph offers a greater protection to life, as in reality only a protection to property is apparent; but in this latter respect it is of an unlimited value, and cannot be too highly appreciated. With regard to the saving of lives, the official figures of the "Reports of the Chief Officer of the Metropolitan Fire Brigade" indicate sufficiently that the death-rate is influenced chiefly by circumstances intimately connected with the very outbreak of fires. Over these even the speedy call of the brigade seems to have but little control, and the rate is principally kept at its low figure by the renowned bravery and deeply-rooted sense of duty of the corps of the London Fire Brigade.

We are here confronted with the rather unexpected, but nevertheless correct, result that, although the increase of the fire brigade and the further development of the fire-telegraph had a decided influence upon the decrease of "serious fires," and consequently upon a greater protection of property, those increased advantages had nevertheless no apparent effect in increasing the protection of life. It appears, therefore, that the Metropolitan Fire Brigade has long since arrived at the utmost limit which human efforts could attain for the protection of life in cases of fires, viz., at the low average of about two lives lost per 100 fires—a minimum which even the introduction of increased means of rapid communication could not diminish in London.

With regard to this question it must, however, be kept in mind that London is not yet sufficiently provided with electrical call-points for giving fire alarms, having only one alarm point for about every 6,880 inhabitants; whereas other towns better provided with fire annunciators, such as Cologne, Nuremberg, Munich, Amsterdam, Stockholm, Chicago, New York, &c., possess one alarm-point to about every 2,000 or less inhabitants. It is thus not impossible that a further decrease in the percentage of lives lost during London fires might result from a considerable increase of fire annunciators.

As regards towns with "alarm" points, *i.e.*, with fire stations and police stations in communication with the same but not with *street* calls, with the exception of Cork, Nottingham, and Manchester, the percentage of serious fires has everywhere been reduced. And, again, with the exception of Sunderland, Brighton, Cork, Oldham, Blackburn, and Bradford, the proportion between public alarm-points and inhabitants has likewise been everywhere considerably increased, so that a general increase of alarm-points and a general decrease of serious fires has taken place in provincial towns as well as in the metropolis.

But these results, however gratifying in themselves, are nevertheless not yet quite satisfactory. It is only too clear that fire-telegraphs have not yet attained that popularity and usefulness in British towns which they have enjoyed for a long time in Holland, Germany, America, and elsewhere, and which they really merit. The proportion of inhabitants to alarm-points in the former towns ranges as high as 20,000 to 30,000, and even—as is the case in Cork, Preston, and Blackburn—to 80,000, 100,000, and 115,000 inhabitants respectively to one single alarm-point; whereas most of the Dutch, German, and American towns possess an alarm-point to every 2,000 or 3,000 inhabitants.

The consequences of such vast differences in public facilities for raising fire alarms naturally show themselves in a considerably higher percentage of serious fires in British towns, of which it is only necessary to mention Liverpool with 19 per cent., Bradford with 28 per cent., Sunderland with 41 per cent., Cork with 50 per cent., and Hull with 64 per cent. of serious fires.

The towns which have already adopted electrical *street* call-points are still very few in this country, and we can only mention here London, Leeds, Nottingham, Glasgow, Newcastle, Bolton, and Dublin.

As regards foreign towns, the first Amsterdam street call-points were erected at the end of 1874, and the average percentage of serious fires before that time was as high as 10, whereas there is now an average of only 3·5 per cent. of serious fires.

The number of lives lost at Amsterdam shows in a certain respect a remarkable coincidence with those lost at London fires and at many other towns, viz., the percentage of lives lost from fires does not seem to be visibly influenced by an increase of alarm points. On the contrary, there is sufficient evidence to show that, in spite of a general increase of fire stations, of rapid alarm signalling, and of extended telegraphic communication between fire stations, there is a decided tendency in modern fires to become more and more fatal. The causes of this destructive tendency, which even a combined and increased efficiency of the fire brigade and the fire-telegraph has not been able to conquer to any visible degree, seem to be the same in this as in other countries.

With the exception of Magdeburg, the serious fires in all other German towns have decreased; and the proportion between public alarm points and inhabitants, being already at the high ratio of 1,000 to 7,000 inhabitants to each alarm point, has mostly been further increased, and only in a few instances has it slightly altered for the worse.

The same favourable observations hold good for American towns, with this important difference, however, that fire-telegraphs in America are far more popular than in Germany and England, showing a proportion between public alarm points and inhabitants of from 500 to 2,000 inhabitants to each alarm point.

After having reviewed the fire-telegraphs of a number of towns, British and foreign, the conclusion to be drawn is, that the primary object of all fire-telegraphs ought to be the reduction to a minimum of the time which elapses between the discovery of a fire and the appearance of the brigade on the spot, so as to prevent as much as possible the chances of a fire becoming "serious."

The results before us prove that this cannot be attained by a fire brigade, however well equipped and organised, unless assisted by a telegraph system which possesses the means of reducing delay to a minimum.

These means principally consist in the adoption of a large number of electrical street call-points.

How much the time elapsing between the raising of the alarm and the appearance of the brigade can practically be reduced by the aid of such a fire-telegraph system, could easily be shown by extracts from numerous official reports.

In Brooklyn, America, although the number of fires has doubled since 1876—say 385 in 1876, and 800 in 1886—the loss of property nevertheless amounts now to only about half of what it was in 1876, or, in round figures, $500,000 against $1,000,000. Whereas the average loss of property per each fire amounted to about $2,000 in 1876, it only amounts now to about $800. This reduction in the yearly loss of property through fires is a natural consequence of the decrease of serious fires—viz., from 16 per cent. in 1876 to 9 per cent. in 1886—and it is mainly due to the gradual increase of public fire alarm-points, which in 1876 amounted to only 22, whereas in 1886 there were 321 public alarm-points in Brooklyn. A similar result has been obtained in New York.

One of the most striking indications that the number of lives lost and persons injured through fires is not dependent on the efficiency of the fire brigade, is contained in the official reports of the Commissioner of the New York Fire Department. There we have a fire brigade which can boast of possessing all the most modern appliances of a perfect fire equipment, and of surpassing everyone in rapidity of appearing at the place of conflagration; and still, out of 606 persons killed, and fatally, seriously, and slightly injured through fires during the years 1879 till 1886, only 9 of these cases happened after the arrival of the fire brigade, but 597 persons are registered as being killed or injured "before the arrival of the brigade."

These facts must lead us to the conclusion that the protection of life is not so much influenced by a greater efficiency of the fire equipment and by the extension of fire-telegraphs, but that it chiefly depends upon factors which lie very much beyond the reach of even the most efficient brigade. On the other hand, it would be blindness to overlook the repeated cases, officially reported by many fire departments, which testify that frequently the names of firemen have been placed on the roll of honour for heroic bravery displayed in saving life, rescuing with great personal risk to themselves persons from a third, fourth, or fifth storey. But even these cases have not been sufficient to produce an apparent decrease in the rate of fatalities, and the best that can be said is, that probably the list of fatal cases would have increased still more had not the number of alarm-points generally been increased during later years.

The tendency of modern fires to become more fatal than in former years will have to be looked for in structural and industrial circumstances, in the concentration of population, and in the greater accumulation of inflammable household and other materials. I therefore agree with the chief officer of the Berlin Fire Department, who opines that the percentage of lives lost has been increased, in spite of increased fire-alarms and increased efficiency of the brigades, in consequence of a proportionately much greater number of lately erected factories and other establishments of a more inflammable nature.

I am well aware of the difficulty, or, rather, impossibility, of a correct classification of "serious fires." There is, unfortunately, no recognised "unit" by which to classify the seriousness of a fire, and hence such statistical tables cannot claim anything like perfection or mathematical exactness until a standard unit is recognised and used by all the fire departments. Generally speaking, a "serious fire" is to be understood as a fire for the extinction of which more than two engines or reels were required. But this unit is not everywhere adhered to. Some fire brigades have adopted a much lower standard, and consider every fire as serious where more than one reel or engine, instead of two reels or engines, were required. This lower standard naturally gives rise to a much higher percentage of serious fires—as, for instance, is the case in the reports of the Munich Fire Brigade, where an average of 14 per cent. of serious fires, in conjunction with a proportion of one alarm-point to every 2,000 inhabitants, appears entirely out of proportion; and a much more favourable result would be obtained had Munich adopted the standard of the two reels or engines. Other towns adopt the amount of property damaged or destroyed as the standard of comparison. Thus, for instance, at Manchester "serious fires" mean such where one-sixth or more of the property was damaged or destroyed. This is rather a high standard, and hence the comparatively favourable result of only 6½ per cent. of serious fires in conjunction

with the low proportion of one alarm-point to every 20,754 inhabitants.

In the discussion which followed the reading of Mr. TREUENFELD's paper,

Mr. SHARP gave a description of the "Connaught Fire Alarm" apparatus (ELECTRICAL REVIEW March 2nd). He pointed out the great advantage which alarms of the description possessed in giving very early notice of the commencement of a fire. He thought the non adoption of such alarms was due to ignorance of the fact that such alarms existed, and in some cases alarms of an unreliable character had caused a prejudice against them. The demand at present was for more firemen and higher insurance rates; he thought the adoption of automatic alarms would greatly diminish this demand. The Connaught alarm system had been in use for four years in America in a large number of mills, and no insurance claim had had to be paid on account of fire in such mills, as the alarms had always enabled incipient fires to be detected and at once extinguished.

Mr. CRAWLEY explained an alarm system of his which had been tried with success in Portland Road; in this system a single wire passed through a number of call boxes which contained pendulums whose rate of vibration differed and which by interrupting the circuit at a definite rate actuated the required indication at the fire or alarm station.

Mr. E. BRIGHT considered that automatic alarms were the only means which would enable fires to be properly grappled with. He had advocated their use constantly since 1877, but with no result. He had communicated with the insurance companies on the subject, but had received as an answer that they did not want automatic alarms to be used, as it would result in their insurance premiums falling off.

Mr. HIGGINS had had the same experience as Mr. Bright. His company had set up 800 alarm signals, but of these only six were paid for.

Mr. HALL, on behalf of the insurance companies, expressed his surprise at Mr. Bright's statement. It was true, however, that if the public believed too much in automatic appliances insurance companies would be extinguished. The question of alarms, however, had nothing to do with the companies, as the latter did not undertake to extinguish fires. The companies liked small fires in the suburbs and heavy premiums in the City. Automatic alarms, he thought, gave a false security, as being unreliable they in many cases did not give a call, and thus a fire would take a strong hold before being noticed. He agreed as to the difficulty of defining a serious fire; in some cases the number of fires was defined as the number of houses burnt; in others the whole conflagration was called one fire, although it might comprise a large number of houses. He thought too much credit had been given to fire alarms, as, concurrently with their erection, the strength of the fire brigade had been increased. He would mention that in spite of the elaborate system of alarms in America the insurance business there had been anything but profitable of late years.

Captain SHAW said that there was very little to criticise in Mr. Treuenfeld's paper. The delay which had been complained of in the introduction of fire-alarms was easily explained, it was simply a question of the exigencies of public life. He admitted that the introduction of call-points had been attended with very beneficial results. During last year there had been in London 2,363 calls, 1,195 of which had been given by the street alarms; 170 of these were, malicious, and 74 were due to unknown causes; 91 resulted from faults on the lines, 13 were due to insignificant fires, and 14 were caused by collisions of vehicles against the alarm posts. There was thus a total of 820 good and 375 false calls. In many cases the calls had resulted in lives being saved by the men on the engine. He had experienced great trouble in getting reliable statistics from foreign countries; in the case of those from America it was simply impossible to comprehend their meaning. As regards automatic alarms, he thought their value and reliability had been exaggerated. As regards their use in America, he would state that they had almost always been put up by insurance agents, who had a commercial interest in selling them. He thought however that a great deal of their unsatisfactory working was due to the fact that in the first instance these appliances were put up by commercial men who had practically no electrical knowledge. As regards the street-alarms, he thought the only way to prevent malicious calls would be to arrange the apparatus so that when it was actuated a very loud noise should be made at the point, so as to attract attention and cause the apprehension of the offender. He considered that it was of great importance that the alarms for warehouses, when these were adopted, should not be mere bells, but speaking appliances, so that the nature of the fire and the kind of assistance required could be stated: where telephonic communication had been adopted, it had proved of the greatest possible service.

Mr. TREUENFELD having replied briefly, the meeting adjourned.

Physical Society, March 10th, 1888.

Prof. REINOLD, President, in the Chair.

Mr. C. E. Burton was elected a member of the Society.

Mr. G. L. ADDENBROOKE exhibited and described a compact form of reflecting galvanometer, lamp and scale, which he has designed as a portable commercial instrument, and also a modified Post Office Wheatstone bridge. In the galvanometer the coils are easily removed or replaced by others, and loose wires for connecting the coils together are avoided, the required connections being made through the screws which secure the coils in position. The suspension is arranged so that the needle can be quickly taken out without breaking the fibre, and replaced by another for ballistic purposes if necessary. A simple liquid damping arrangement is provided. The lamp (a paraffin one) is enclosed in a copper cylinder, which also supports the scale. The height of the lamp and scale can be varied, and the beam of light can be directed at different altitudes by having the lense tube mounted on pivots, the line joining them passing through the centre of the flame. The whole is very compact and portable. (See p. 289.)

Mr. E. C. RIMINGTON read a paper "On the Measurement of the Power Supplied to the Primary Coil of a Transformer." The first part of the paper contains a proof of a formula given by Prof. Ayrton at a recent meeting of the Society of Telegraph-Engineers for measuring the power given to a transformer by using a Siemens wattmeter, and the disadvantages of the method are enumerated. A method is then described in which a high resistance dynamometer is used. One coil of the dynamometer is placed as a shunt to the primary coils and the other as a shunt to a known inductionless resistance, R, placed in series with the primary. The time constants of the dynamometer coils are made equal by adding an inductionless resistance to the one having the greatest time constant. Thus arranged, the difference of phase between the currents in the dynamometer coils is the same as that between the P, D, and current in the primary of the transformer. The mean power, p_m, is shown to be

$$p_m = \frac{K}{R}\,\delta\,(1 + \tan^2\phi_1)$$

where $\frac{K}{R}$ is the constant of the dynamometer for *watts*, δ the reading of the torsion head, and ϕ_1 the lag angle of the currents in the coils of the dynamometer, which can be determined from their time-constant and periodic time. The best method of arranging the dynamometer in order that R may be as small as possible is discussed.

Prof. AYRTON pointed out that the formula first referred to by the author, was given to show *why a wattmeter should not be used*, and that the method suggested by Mr. Rimington was a modification of the well-known electrometer method, but with an additional serious objection, that the periodic time must be known. He also described a direct-reading method of using an electrometer on ordinary transformer circuits suggested to him by Mr. Sayers.

Mr. BLAKESLEY thought the above formula given by Mr. Rimington would only be true when there is no iron in the circuit. He described a method of determining the power by observations on two low resistance dynamometers, one of which is placed in the primary circuit. Of the other dynamometer, one coil is placed in the primary and the other in the secondary circuit. The power is given by $p_m = A\,a_1 r_1 - r_2 \frac{m}{n} C\,a_3$; where r_1, r_2, are the resistances and m, n, the numbers of convolutions of the primary and secondary coils, A and C the constants of the dynamometers, and a_1, a_3 their readings. A geometrical construction from which the formula is deduced was given.

Mr. SUMPNER said all the formulæ at present obtained were founded on the assumption that the induction coefficients of a transformer under working conditions are constant, but in a paper to be brought before the Society shortly, he hoped to show these assumptions to be erroneous.

In replying, Mr. RIMINGTON said, if the periodic time was not known beforehand, it could easily be determined from the note given out by a telephone placed near the transformer.

"On the Magnetic Circuit in Dynamo Machines," by Prof. W. E. AYRTON and Prof. J. PERRY. An abstract was read by Prof. PERRY. The authors have worked out a number of formulæ for dynamo machines involving the thickness, t, of the armature winding, and a the highest permanent current density per sq. cm. of cross section of that winding. One of them is

$$W = \frac{2\,v\,N\,t\,a}{10^8}$$

where W = highest permanent output in watts, v = circumferential velocity, and N = total induction through the armature. As the winding is thin, $t\,a^2 = q^2$ a constant. For the best modern machines which do not get too hot, q has a value of about 288. It is shown that the best permanent output is a maximum when the magnetic resistance of the space occupied by the armature winding is equal to all the other magnetic resistance in the circuit, and the best machines are found to satisfy this condition. From this important result the characteristic of such a dynamo can be drawn with considerable accuracy. For small inductions the air resistance only need be considered, and a line drawn on squared paper, connecting N and $S^1 A^1$, satisfying

$$N = \frac{4\pi S^1 A^1}{10} \div \frac{2\,(d + t)}{a_2}$$

gives the first part of the characteristic, where $S^1 A^1$ = ampère-turns, d = clearance, and a_2 the area of the pole-pieces exposed to the armature (increased by a fringe of 0·8 $(d + t)$ all round). From the maximum value of N (viz., $a_1\,\beta_1$) where a_1 = area of diametral section of iron in the armature, and β_1 = maximum induction (17,000 to 18,000) find the value of $S^1 A^1$ from the formula

$$N = \frac{4\pi s^1 A^1}{10} \div \frac{4t}{a_2}$$

and plot the values of N and $s^1 A^1$ as the co-ordinates of a point. A curve drawn through this point to touch the line first drawn at a point corresponding with $N = \frac{1}{2} a_1 \beta_1$ will not differ materially from the characteristic of the constructed machine.

A note "On the employment of an electro-dynamometer for determining the difference of phase of two harmonic currents of electricity," by Mr. T. H. BLAKESLEY, was taken as read. This is a claim of priority for a method published by the author in the *Electrician* of October 2nd, 1885, which has recently been described and claimed as the invention of Prof. Ferraris, in a paper communicated to the Royal Academy of Sciences of Turin. In a book on alternating currents published at the end of 1885, Mr. Blakesley shows how the method can be used for determining induction coefficients and capacities.

NEW PATENTS—1887.

18030. "Improvements in thermo-electric batteries." L. C. E. LEBIEZ and P. L. VERCHERE. Received March 5, 1888. Antedated November 8, 1887. Under international convention.

1888.

3223. "Improvements in secondary batteries." W. KINGSLAND. Dated March 2.

3230. "Improvements in electrical tramways and railways." F. C. ALLSOP. Dated March 2.

3235. "Improvements in multipolar dynamo-electric machines." G. MIOT. Dated March 2.

3246. "Improved electrical lamp and projector, and method of applying same for maritime and other purposes." F. WALKER. Dated March 2. (*Complete.*)

3286. "Improvements in electrical measuring instruments." G. L. ADDENBROOKE. Dated March 3.

3303. "Improved apparatus for registering the consumption of electric energy." H. H. LEIGH. (Communicated by J. L. Clerc, Paris.) Dated March 3.

3312. "An improvement in voltaic batteries." E. TYER. Dated March 3.

3328. "Improvements in electric contact makers and commutators." C. LANGDON-DAVIES. Dated March 3.

3359. "Improvements in apparatus for operating or controlling type-setting machines, type-writers, and the like by the aid of electricity." E. F. LAW. Dated March 5.

3371. "An improved method of attaching the caps or covers of electrical fittings to their bases so as to form an air-tight joint." C. K. FALKENSTEIN and S. SUDWORTH. Dated March 5.

3456. "Improvements in electric bells or ringing apparatus." W. H. WINNALL. Dated March 6.

3483. "Improvements in electrical switches." F. T. SCHMIDT. Dated March 7. (*Complete.*)

3498. "Improvements in and relating to alternating current dynamo-electric machines." T. PARKER. Dated March 7.

3504. "Multiple electric communication." J. OLDFIELD. Dated March 7.

3515. "Improvements in telephonic apparatus." H. COLLETT. Dated March 7.

3517. "Improvements in primary batteries." R. DISHER. Dated March 7.

3535. "Improvements in electric conductors." W. B. FITCH. Dated March 7.

3550. "An electrical regenerative battery." N. G. THOMPSON. Dated March 8.

3557. "Increasing the light produced by electricity by a combination of bracket and shade concave." C. W. HAETLEY. Dated March 8.

3567. "Electro-melodic action for organ and similar wind instruments." T. HARRISON, jun. Dated March 8.

3571. "Improvements in telephonic transmitters." T. LAURIE. Dated March 8.

3590. "Improvements in electrical transformers and plates therefor." J. G. STATTER. Dated March 8.

3593. "Improvements in the construction of cells or jars of electric batteries." R. WALKER. Dated March 8.

3614. "Improvements in dynamo-electrical machines." S. ZIANI DE FERRANTI. Dated March 8.

3618. "Improvements in fire-alarm telegraphs." H. A. C. SAUNDERS and A. C. BROWNE. Dated March 8.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

4112. "Improvements in electric arc lamps." H. WEBER and R. SCHEFBAUER. Dated March 18. 8d. This arc lamp differs essentially from those heretofore constructed, inasmuch as, first, it is not what is called a "free fall lamp," that is to say, a lamp in which the weight of the upper carbon holder overcomes that of the lower, whereby, when the current is not passing, the upper carbon sinks automatically, and thereby simultaneously raises the lower carbon. Secondly, the upper as well as the lower carbons are not actuated by the power of a spiral spring. And thirdly, the lamp is void of all clockwork and band connections, as well as of long racks or guiding rods, which require the upper structure of the lamp to be of such a length or height as to equal the united length of the two carbons. The claims are 4 in number.

7720. "An improved telephone switch." S. S. BROMHEAD. (Communicated from abroad by C. A. Hitchcock, of America.) Dated May 27. 8d. The object of the invention is to provide a switch mechanism which is reliable, durable, and simple in construction, and in which the liability of the corrosion or destruction of the electrodes or contact points is effectually prevented. Another object is to improve upon the construction and arrangement of a telephone-switch system, in which fixed mercury contact-cups are combined with electrodes carried by a movable bar, operated by a lever. The claims are 6 in number.

7934. "An improved electric switch." A. B. GILL. Dated June 1. 6d. The object of this invention is to construct a switch for making and breaking an electric circuit, which shall have a powerful pressure imparted to the points of contact. The switch may be so constructed that the lever (which in some cases carries the current) when turned, enters a frame which carries the spring and contact piece, or pieces, or other arrangement, which when properly shaped, it raises against the pressure of a spring or springs, thus the lever or contact piece is firmly gripped and good contact ensured. There is 1 claim.

9196. "Improvements in apparatus for changing or regulating electric currents." A. J. BOULT. (Communicated from abroad by Dr. S. Doubrava, of Prague.) Dated June 28. 8d. Claims: 1. For the changing of high tension alternate current into low tension alternate currents, the employment of condensers in which the charging surface is smaller in a fixed ratio than the discharging surface, substantially as specified. 2. For the changing of a high tension continuous current into a low tension alternate current, the employment of condensers in which the charging surface is smaller in a fixed ratio than the discharging surface in combination with a current breaker connecting the charging surface of the condenser alternately with the opposite poles of the generator, substantially as specified. 3. For the changing of a high tension continuous current into low tension continuous current, the employment of condensers in which the charging surface is smaller in a fixed ratio than the discharging surface in combination with a commutator connecting the condensers in series for charging, and in parallel arc for discharging, substantially as specified. 4. For double changing of the current, the employment in combination of two condensers as described, one of which increases the tension, while the other decreases it, substantially as specified.

9729. "Improvements in or relating to electric converters." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 6d. Claims: 1. The combination of primary and secondary conductors, a core of soft iron plates circular in form, each plate having two openings for receiving the coils, the metal about each opening being cut apart, substantially as described, and a cylindrical enclosing case for the same. 2. An electric converter consisting of primary and secondary coils, a core of circular soft iron plates or discs, and an enclosing tube of soft iron. 3. An electric converter consisting of primary and secondary coils, a core of soft iron cylindrical in form and composed of thin plates, in combination with a lamp-post of iron, having a cylindrical opening containing the same, and in magnetic connection therewith. 4. An electric converter consisting of primary and secondary coils, and a core composed of soft iron plates, and a solid back piece common to all the plates. 5. An electric converter consisting of primary and secondary coils, and a core consisting of laminæ of soft iron magnetically separated through the greater portion of their surfaces, and magnetically united at their edges. 6. An electric converter consisting of the combination of primary and secondary conductors, and a core of soft iron plates, and an enclosing case of soft iron. 7. The combination with the primary and secondary coils of a converter, and a core of soft iron to which they are applied, of a soft iron enclosing case for the same.

9730. "Improvements in or relating to voltmeters." W. P THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. The object of the invention is to provide means for securing as great an amplitude of movement of an indicating device as possible from a given variation in the electromotive force of the current traversing the same, and to reduce to a small fraction the error due to the change in resistance of a metallic coil. One or more electric lamps are introduced in the circuit, in series with the coil of the indicator. These serve to increase the effect due to any variation, by reason of the change which occurs in their own resistance under the influence of an increase or decrease in the electromotive force of a current traversing the indicator coil. The claims are 7 in number.

9732. "Improvements in or relating to electrical indicators." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. Relates to the class of apparatus employed for indicating at any time the current upon an electric circuit; and the object is to provide convenient means for determining and regulating at a central station the potential upon the work circuit. The claims are 9 in number.

9734. "Improvements in or relating to the transmission of electricity from sources distant from where they are to be utilised." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. Claims:—1. The described method of electrical distribution, which consists in generating currents of high potentials, transmitting the same to remote points, there converting them into secondary currents of lower potential, transmitting the converted currents to points in the more immediate vicinity of the points of consumption, and there reconverting them into tertiary currents of still lower potential and transmitting the last named currents to the points of consumption. 2. The described method of electrical distribution and supply, which consists in generating currents of high potential at a point remote from the point of consumption, and reducing the electromotive force step by step during its transmission to the point of consumption. 3. The described method of electrical distribution which consists in transferring electrical energy from a high potential supply circuit to a lower potential consumption circuit, through an interposed electrically insulated circuit.

9735. "Improvements in or relating to electrical distribution." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America. Dated July 12. 8d. Claims:—1. The combination, substantially as described, of a source of electricity, two main lines, converters having their secondary coils connected with different points along the length of said main lines, conductors connecting the source of electricity with the primary coils of the respective converters, and one or more converters having their primary coils respectively included in the last named conductors and adjustable resistances included in the secondary coils, substantially as described. 2. The combination, substantially as described, with two or more alternate current generators, of a source of electrical current supplying the field magnet coils of the same conductors with which said generators are connected in multiple arc, a system of feeding conductors connected therewith, translating devices, and a main line with which said translating devices are connected, and converters located along the main line, having their secondary coils connected therewith in multiple arc and their primary coils connected with the feeding conductors aforesaid.

9736. "Improvements in or relating to connecting alternate current electric generators and to apparatus therefor." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. The object of the invention is to provide means for determining the relative phases of two or more electric generators for delivering alternating currents for the purpose of rendering it possible to bring them together in multiple arc circuit without injury to the circuits which they are designed to supply. The claims are 13 in number.

9737. "Improvements in or relating to electrical distribution and conversion." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. Consists, in general terms, in employing in an electric lighting system a converter having its secondary coil formed in sections from which independent conductors lead to corresponding switch-points. The translating devices or groups of the same may be connected in circuit between one terminal of the secondary coil and any one of these switch-points at will, and thus the potential of the current yielded to the translating devices may be diminished or decreased as required. By the use of this means of regulation the reduction of current in the lamps is accomplished by a saving of power, whereas in the usual method, in which resistance is introduced in series with the lamp, a certain amount of energy must be wasted in the resistance. The claims are 5 in number.

9738. "Improvements in or relating to electrical distribution and conversion." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. The object of this invention is to make it possible to extend the secondary conductors to greater distances from the converter-stations, and thus reduce the number of such stations and the feeders required, and to do this without increasing the size of the main-conductors to an undesirable extent. To accomplish this the converters are grouped and connected in the system in a peculiar way. The claims are 5 in number.

9739. "Improvements in or relating to electric circuits and automatic controlling apparatus therefor." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. The object of the invention is especially to provide means for supplying the required currents in such manner that should there be any interruption in the connection of any given supply conductor, there will be a convenient means at hand for substituting therefor or interchanging therewith another supply conductor, thus providing a path for the currents until the original circuits are repaired. The invention relates especially to the system of electrical distribution in which alternating electric currents are transmitted over main conductors to points near the stations at which they are to be utilised, at which stations electric converters are employed for transforming the currents. The claims are 9 in number.

9740. "Improvements in or relating to electrical distribution." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. From a generator or other source, alternating, intermittent, or pulsatory currents are derived. Such currents are transmitted either directly or through one or more electric converters, to two conductors extending to points at or near which the translating devices are to be located. The translating devices are arranged in groups, one terminal of each translating device in the group being connected with one of the conductors referred to, while the remaining terminals of the devices in that group are all connected together. The devices in the second group each have one terminal connected with the second conductor and their remaining terminals united with the connected terminals of the first group. One coil of an electric converter or induction coil is connected between the united terminals of one group of the translating devices and one of the conductors, and the other coil is connected between the united terminals and the other conductor. In case it is desired to maintain the same difference of potential at the terminals of the different translating devices of any two different groups thus formed, then the coils of the corresponding converter are preferably of equal value; if, however, it is desired to supply currents of a greater difference of potential to one group than to the other, then the coil connected in parallel circuit therewith is of greater length or greater inductive value. The claims are 4 in number.

9741. "Improvements in or relating to electrical distribution, or to apparatus for supplying or distributing electricity to electric railways, incandescent lamps, or other like purposes." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. Consists generally in employing, in connection with a supply circuit and an electric converter receiving currents therefrom, an alternate-current motor serving to operate a commutator which serves to rectify or straighten any required portion of the current. This rectified current may be employed for useful work, and also to charge a storage battery. The current from the storage battery is reserved until it is required for supplying the circuit which is normally supplied from the main line, or for supplying other circuits. The claims are 11 in number.

9745. "Improvements in or relating to converting electric currents into currents of different potential." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 8d. The general plan of the invention consists in the transmission of alternating, undulatory, intermittent or pulsatory currents, the potentials of which is designed to be varied, through an inductorium of improved construction, consisting of a mass of iron or other magnetic metal situated in inductive relation to a continuous conductor, so constructed and arranged that the whole or any required portion of such conductor may also be included in one or more secondary circuits. The current traversing said conductor serves to produce a magnetic field, and the magnetic changes thus produced in the field, in turn set up a counter electromotive force and produce an induced current in the whole or any required portion of the same conductor. The claims are 7 in number.

CORRESPONDENCE.

Magnetic Resistance.

There is, if I mistake not, a little slip of the pen in Mr. E. C. Rimington's note on magnetic resistance on p. 280, ELECTRICAL REVIEW. The equation

$$\phi = \mathrm{A\,B} = \mathrm{A}\,\mu\,\frac{4\,\pi\,n\,c}{l} = \frac{n\,c}{\frac{\mu}{4\,\pi}\cdot\frac{l}{\mathrm{A}}}$$

has a misplaced "mew" (μ) in it; it should be written

$$\phi = \mathrm{A\,B} = \mathrm{A}\,\mu\,\frac{4\,\pi\,n\,c}{l} = \frac{n\,c}{\frac{1}{4\,\pi\,\mu}\cdot\frac{l}{\mathrm{A}}}.$$

Hence from Mr. Rimington's way of regarding it the specific magnetic resistance per cubic centimetre is $\frac{10}{4\,\pi\,\mu}$ and not $\frac{10\,\mu}{4\,\pi}$ as stated. There is an objection I think to numerically measuring the magnetomotive force by the ampère turns simply. It is better following Mr. Bosanquet (See *Phil. Mag.*, Vol. 17, p. 536, 1884, V. Sec. and also *Phil. Mag.*, Vol. 15, p. 207, V. Sec., 1883), to numerically measure the magnetomotive force by $4\,\pi\,\times$ the ampère turns.

Adopting Mr. Rimington's symbols we can then write

$$\phi\ (\text{total magnetic induction}) = \frac{\text{magnetomotive force}}{\text{total magnetic resistance of circuit}}$$

and $$\psi = \frac{4\pi \times \text{ampère turns}}{\frac{10}{\mu} \cdot \frac{l}{A}}.$$

This presents the specific magnetic resistance per cubic centimetre of the substance simply as the reciprocal of the permeability when current is measured in C.G.S. or $\frac{10}{\mu}$ for ampères.

Beyond, however, presenting the principal magnetic equation in a form analogous to that of Ohm's law, the result does not help matters forward much, because it has always to be borne in mind that this magnetic resistance not only increases with temperature rapidly, like Ohmic resistance for pure metals, but increases with the magnetic induction which is taken as the analogue of the currents. Hence we are in as poor a plight magnetically as the ordinary wireman would be in electrically if he could not tell roughly the resistance of 100 yards of No. 10 B.W.G. until he knew how many ampères were going to be put through it. In so far as the term "magnetic resistance" is a simple and less cumbersome expression than "reciprocal of magnetic permeability," there is no doubt that it is convenient, but there is certainly such a very wide physical difference between the operation of maintaining a magnetic field in the interior of a body under the action of magnetising force, and that of maintaining an electric current under the action of electromotive force, that it is not by any means certain that it is advisable to express the relation of the one to the other in both cases by a term which conveys the idea of a certain physical similarity between the operations. There is a great attractiveness, however, about generic terms. The term "magnetic resistance" has perhaps taken a little too firm a hold to be uprooted, and will no doubt be generally retained to express the ratio of the difference of magnetic potential between two points on a magnetic circuit or the magnetomotive force, to the total magnetic induction through the normal section of the circuit considered.

The physical phenomena of magnetisation and electric currents are separated by wide differences. The phenomena of electrolysis, electric arc, electric convection, all point to the characteristic of a *flux* or *flow* as one peculiar to the current. Present notions of the nature of electric current effects may be greatly modified in time, but the conception of a *circulation* of some kind has a foundation no doubt of truth in it. The hydro-kinetic analogies are well marked and evident.

Magnetisation finds, however, its closest mechanical analogy in torsion, as long ago pointed out and developed, especially by Wiedemann. The magnetising force, magnetic induction and "magnetic resistance" are closely analogous to the torsional force or couple, the twist or torsion, and the torsional rigidity of the bar. The analogy in this case is closer and more natural than when an effort is being made to wrench round the magnetic phenomena into an apparent similarity with that of steady electric current flow. The hydro-kinetic character of the current enables us to find in E.M.F. current and resistance the analogies of pressure fluid velocity and fluid resistance with the difference that electric resistance is independent of current strength. The whole, or nearly the whole, of the chief magnetic phenomena can be mechanically illustrated by the behaviour of a piece of brass wire when twisted, and the true mechanical analogue of that quality called "magnetic resistance" is to be found in comparing it with torsional rigidity and not with frictional resistance to "flow" of any kind.

J. A. Fleming.

Ships' Compasses.

My attention has been called to a letter in the ELECTRICAL REVIEW for February 24th from Mr. E. de M. Malan on ships' compasses. I do not understand from this letter whether Mr. Malan has placed his compass on a swing bridge on shore. If he has it could be corrected with magnets and soft iron in the same way that the compasses on board iron ships are corrected. If Mr. Malan will send me further particulars I shall be glad to give him instructions for correcting his compass.

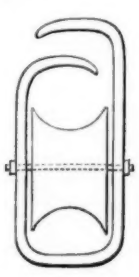
W. Bottomley.

March 7th, 1888.

Renewing Telegraph and Telephone Wires.

I am not the designer or patentee of the runner described in the REVIEW of 2nd inst., but had something to do with the testing of it and of others which turned out less satisfactorily. Perhaps, therefore, you will permit me to reply to the letters which appeared in reference thereto in your issue of 9th inst. With regard to Mr. Gilbert's claim to have "thought of" a similar device I can of course say nothing, but judging from the recent introduction of his renewing levers, it may be understood that he did not think of it until some time after the runner had been brought out. Whatever his claim may be, and in passing it may be pointed out that this is the first that has been heard of it, I am convinced from experience with many appliances, some very like his own, that had he given form to his thought and tried the runner, the levers would never have been heard of. It does however seem a little strange that he should have thought of a runner at all, seeing he is so much opposed to the system of drawing out wires. The thumbscrew is not liable to fail as suggested, nor does the wire swing in contact with those under it when being drawn out. This has been placed beyond doubt by experience during renewal of many hundreds of miles of wires on my own and other sections. Mr. Gilbert's reason, No. 4, is a somewhat extraordinary one, and it is difficult for one occupying a subordinate position to realise that such an idea should be held by a responsible telegraph engineer. I can only account for it by the fact that there are queer things in the far north, and that the violence of the elements there may occasionally necessitate the violation of the usual rules of construction, by putting in poles here and there to hold the wires "*down*" instead of "*up*." In the "south country" telegraph lines are built so that each pole bears its share of the weight of each wire (rudimentary engineering this you will say), and nothing more need be urged to prove that the "*upward pull*" which, in Mr. Gilbert's opinion would lift the wire off the runner, exists only in that gentleman's imagiration. But hold! it may be a feature of the new system of construction of which—like a Yankee gale—warning has just been sent out. If such a thing as an "upward pull" did exist, the curving of the prongs as shown in Mr. Gilbert's design would be an awkward means of providing for it. Why, it would be utterly impossible to twist a stented wire over prongs curved as suggested.

Something like this :—



would do, but is quite unnecessary, and would only be obstructive. It will be seen from the drawings furnished by "(Pi)²," that no provision has been made for "*upward pull*" in the tool used by the N.E. Company. Indeed, upward pull in that case would mean the lifting of the bracket off the arm altogether. There was no risk of this, however, and the designer of the tool seems to have known it pretty well. An almost identi-

cal method of fixing was employed in various tools supplied to and tested by me before the pulley-runner was adopted. It was abandoned, however, in the latter to get rid of the "in" and "out" slip on the arm. The rigid fixture is an advantage, and is quite as quickly obtained as the fixing in the other form. Mr. Gilbert still approves, it seems, of the laborious and expensive system of carrying wire out on drums. I thought this plan had been everywhere discontinued. On uneven ground, which is unfortunately very much the rule on railway banks and public roadsides, and in places where poles and stays are set close up to and frequently over hedges and fences, the men carrying out the drum would have a severe time of it. No, no; it isn't practicable, and what was wanted was a tool adapted to the expeditious and economical system of drawing wires out, which would completely prevent interruptions during renewal operations, and at the same time protect the wire from the not insignificant "scouring" and "skinning" suffered while being drawn over rough ground, or over arms or pulleyless brackets. These results are fully obtained by means of the runners referred to, and I know from the indisputable evidence of the men's time-sheets that they also facilitate the work and considerably reduce expenses. The brackets formerly used cut quickly by the drawing of the wire over them, and from this it can be judged whether the skin of the wire was or was not affected.

Inspector.

Insulation of Conductors for Internal Work.

In commenting on my article on the "Insulation of Conductors for Internal Work," you and your correspondents assume or imply—

1. That I have advocated very low insulation of the conductors for such work.
2. That the class of insulated conductors I mentioned, when used under the conditions I mentioned, gives a very low insulation.
3. That in advocating the employment of conductors for internal work in dry places without rubber insulation, I am suggesting something altogether new and outside present practice.

On the first of these points:

What I really said was this: "It is equally undesirable on the score of expense, and unnecessary from a practical point of view, that the conductors should be insulated up to a very high standard." I did not therefore advocate a low insulation; all I said was that a very high insulation was unnecessary.

I then mentioned the chief requirements in such conductors and pointed out that a wire "with a double or treble covering of stout closely woven braid thoroughly saturated with a good class of what is termed 'compound ozokerit' for preference," fulfilled these conditions.

I did not allude to the relative insulating qualities of ozokerit or rubber, nor did I even speak of the ozokerit compound as an insulator, I simply said it was the best material for preserving the braid and preventing its absorbing moisture. That it is a good insulator is so much more in favour of employing it, but I did not advocate it as an insulator *per se*.

But you and your correspondents are assuming too much in taking it as a fact, that the class of wire I mentioned, used under the conditions I mentioned, would give a very low insulation. If you will lay a hundred feet or two in wood casing you will find that the specific insulation is very fair indeed, and what is more, there is every reason to believe it will rather improve with age than deteriorate.

Now to the third point. You hardly seem fully aware that a large proportion of the wire which has so far been used for internal work is of the class I mentioned, only not so strong mechanically, but with one single lapping of the very thinnest rubber strip. Now what reliance can be placed on such rubber *as an insulator*? In America the very class of wire I advocated has been extensively used. It is true that it is being given up for external work, and rightly so; but I have yet to learn that it has not given perfect satisfaction when used for internal work.

I might bring forward further arguments and proceed to answer you and your correspondents *seriatim*, did time and space permit, but I think what I have said fairly covers the original ground, while I trust it will be sufficient to establish the reasonableness of the views expressed in my original article.

G. L. Addenbrooke.

March 13th, 1888.

The omission in my letter of March 9th was certainly due to my own carelessness; the paragraph should read, "And in addition to this, when the expenses of installation and fittings are taken into consideration, it will be found that the percentage difference on the total cost, whether a well insulated lead or one giving, let us say, only 100 ohms resistance be employed, is but a very inconsiderable figure." But I am not responsible for the errors "sus sibi" instead of "*sui* sibi," or for "eventu nerum" instead of "eventu *rerum*," unless, indeed, my orthography is of as poor a class as Mr. Addenbrooke's 100 ohm "insulation." As to the question of soldering joints, most practical men will, I imagine, agree with Mr. Jeckyll in his preference for rosin as against "spirits," and with the statement that the latter should never be used. I think he has hardly laid sufficient emphasis on the fact that many of the failures in electric lighting circuits are due to the most utter carelessness in making joints. No doubt joints in heavy conductors present considerable impediments to perfect soldering owing to the difficulty of sufficiently heating the wires, and in many cases to the conductors being in such a position as to render the application of heat a troublesome matter. While, however, admitting this as an occasional element of difficulty, it is certain that a far more frequent cause of indifferent joints being made is the want of care too generally shown in thoroughly cleaning the wires about to be soldered—a simple enough precaution, one would imagine.

I think that Mr. Jeckyll's mode of jointing would be improved if, instead of only butting the cores, he were to scarf the ends and bind the scarfed portions with fine lapping wire. In the method he suggests, the mere butting of the centre strands or core would probably result in a very indifferent contact.

With Mr. Jeckyll's last remark, "There are not many places where there the installations have been put up from beginning to end with a view to last," one is unfortunately compelled to absolutely agree.

Anne Insulator.

Transformers v. Secondary Batteries.

I had more than one reason for not giving full figures in support of my argument in favour of "transforming by means of accumulators" at the recent meeting of the Society of Telegraph Engineers.

1. I had already written, at the request of my friend, Mr. Kapp, a memorandum for his paper, and I did not consider myself justified in using the same figures pending the publication of that statement.
2. I prefer to bring these figures forward in a paper of my own, where I should have the right of rejoinder after they have been thoroughly criticised by others. You are, perhaps, aware that I intend to deal with the subject in a paper I am to read before the Society of Arts in May, and I trust that the Council of the Society of Telegraph Engineers will be able to find room for a short paper on the same subject during the present session, so that everyone interested in the question will have ample opportunity of criticising my figures and forming his judgment thereon.

R. E. Crompton.

March 12th, 1888.